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TABLES OF DIELECTRIC MATERIALS



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FEBRUARY 1944

FINAL REPORT

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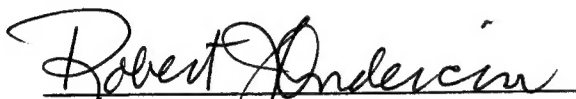
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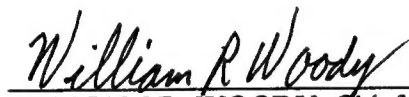
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## Tables of Dielectric Materials

Laboratory for Insulation Research  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

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In coordinating the dielectric research for the National Defense Research Committee our Laboratory has become a clearing house for dielectric information. Materials of all kinds are being measured, new dielectrics are being developed and new instruments are being designed for measuring and applying the properties of dielectric materials. Some results of our measurements in the microwave range have been published previously<sup>1)</sup> in the form of "Tables of Dielectric Materials". Since then it has become apparent that a much more extensive publication is required to facilitate the proper application of dielectrics in the war effort.

The present edition of the "Tables" is a first attempt to satisfy this need. It contains our measurements of dielectric constant and loss for a great variety of materials over a wide frequency range. These data are complemented - thanks to the cooperation of the manufacturers concerned - by information on many other properties, on composition, availability and recommended applications. The materials are grouped in six sections: Ceramics, Glasses, Liquids, Polymers, Waxes and Miscellaneous. A general index arranged according to chemical composition, manufacturer and trade

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1)  
Progress Report on Ultrahigh Frequency Dielectrics - National Defense Research Committee December, 1942. [Confidential] *as amended*

names facilitates the tracing of any substance. An index of abbreviations gives the necessary information about technical terms, units and test procedures.

Dielectric constant,  $\epsilon'$ , and loss tangent,  $\tan \delta$ , are only one set of parameters for describing the interaction of electromagnetic fields with dielectric materials. The alternative concepts of propagation function, intrinsic impedance, complex index of refraction and decibel loss may be more useful in many cases. In two introductory paragraphs therefore a discussion is given of these parameters, of their definition and transformation by conversion formulas and nomographic charts.<sup>2)</sup>

For a proper appraisal of the information contained in the dielectric characteristics some knowledge is needed of the physical phenomena producing polarization. Consequently a paragraph has been added illustrating the effects of ions, electrons and dipoles and the influence of temperature and humidity upon the response characteristics. Our measurements in most cases refer only to room temperature and pre-dried samples, because our facilities were overtaxed. The reader has to use some judgment in working with the "Tables". They are a guide allowing a reasonable approximate choice of materials, but a final selection should only be taken after consultation with the manufacturer concerned.

---

2)

For a more complete theoretical discussion see:

A. von Hippel and R. G. Breckenridge "The Interaction Between Electromagnetic Fields and Dielectric Materials" - National Defense Research Committee January, 1943. [Restricted] *as ordered*

The "Tables" here presented are the result of a cooperative effort: the measurements group of the Laboratory supplied untiringly the dielectric data; the instrument development group, the equipment; and the material development group, the samples. Our task would have been impossible without the support of the manufacturers, who patiently filled out questionnaires and made freely available information and material in the interest of the war effort.

---

Suggestions and criticism from the users of these "Tables" are invited.

A. von Hippel, Director  
Laboratory for Insulation Research  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

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Parameters Describing the Properties of Dielectric Materials.

A condenser of unit dimensions, filled with the dielectric in question and connected to a generator producing a sinusoidal electric field strength

$$(1) E = E_0 e^{j\omega t}$$

carries a displacement current of the density

$$(2) J = \epsilon^* \frac{\delta E}{\delta t} = (\epsilon' - j\epsilon'') \frac{\delta E}{\delta t} \quad (\text{fig. 1})$$

Definitions:

Complex dielectric constant =  $\epsilon^*$

Real dielectric constant =  $\epsilon'$

Loss factor =  $\epsilon''$

Loss tangent =  $\tan \delta = \frac{\epsilon''}{\epsilon'} = \frac{\text{loss current}}{\text{charging current}}$

Power factor =  $\cos \theta$

Dielectric conductivity =  $\sigma = \epsilon''\omega$

"Q" =  $\frac{1}{\tan \delta} = \frac{\text{energy stored}}{\text{energy dissipated}} \text{ per cycle}$

The field strength of a plane electromagnetic wave travelling through a dielectric material, dies down exponentially (fig. 2)

$$(3) E(x) = E_0 e^{-\gamma x} = E_0 e^{-(\beta + j\alpha)x}$$

Definitions:

Propagation function =  $\gamma$

Phase factor =  $\alpha = \frac{2\pi}{\lambda}$

Attenuation factor =  $\beta$

Index of absorption =  $\kappa = \text{attenuation factor per radian}$   
 $= \beta \frac{\lambda}{2\pi} = \frac{\beta}{\alpha}$

Index of refraction =  $n = \frac{\lambda_0}{\lambda} = \frac{\text{wavelength in vacuo}}{\text{wavelength in dielectric}}$

Complex index of refraction =  $n^* = n(1 - j\kappa)$

## Current - Voltage Diagram of a Dielectric with Loss

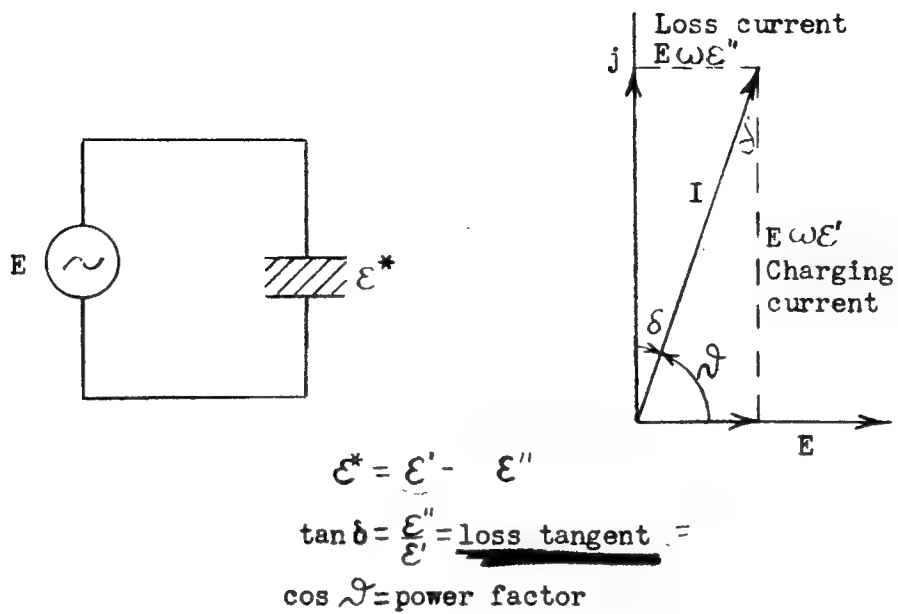


fig. 1

## Attenuation of 0.1m. Wave in Water as Function of Distance

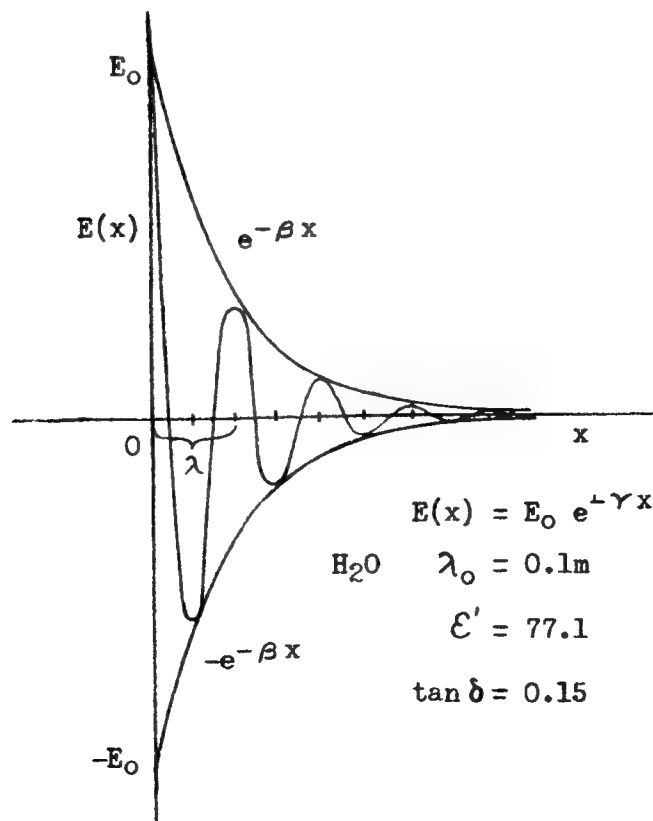


fig. 2

The relation between the propagation function and the complex index of refraction is:

$$(4) \gamma = j \frac{\omega}{c} n^*$$

The relation between the propagation function and the complex dielectric constant (following from Maxwell's "wave equation", which connects the field intensity of the electromagnetic wave in space and time) is:

$$(5) \gamma^2 = -\epsilon^* \mu \omega^2 \quad (\mu = \text{magnetic permeability})$$

- - - - -

Instead of describing a dielectric material by the current voltage characteristic of a condenser or by the propagation of the electric field, it can be defined by the ratio of electric to magnetic field intensity at any point of the infinite dielectric:

Definition:

$$\text{Intrinsic impedance} = Z_0 = \left( \frac{E}{H} \right)_x = \sqrt{\frac{\mu}{\epsilon^*}} = \frac{j\omega\mu}{\gamma}$$

- - - - -

Units and Dimensions:

$\epsilon_0$  and  $\mu_0$ , the dielectric constant and permeability of free space, have in the rationalized m.k.s. system, the values:

$$\epsilon_0 = 8.854 \times 10^{-12} \left[ \frac{\text{farad}}{\text{meter}} \right]$$

$$\mu_0 = 1.257 \times 10^{-6} \left[ \frac{\text{henry}}{\text{meter}} \right]$$

Their product is determined by the propagation velocity of the electromagnetic waves in vacuo, the light velocity

$$(6) c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} = 2.998 \times 10^8 \text{ [m sec}^{-1}\text{]}.$$

The "relative" real dielectric constant  $\epsilon'/\epsilon_0$ , given as  $\epsilon'$ , and the loss tangent,  $\tan \delta$ , plotted in our "Tables" are independent of any system and are without dimensions.

- - - - -



Conversion Formulae and Nomographic Charts.

The dielectric conductivity can most easily be calculated from the expression:

$$(7) \sigma = \frac{\epsilon''/\epsilon_0}{60 \lambda_0} [\text{ohm}^{-1} \text{ cm}^{-1}] \text{ or } \frac{\epsilon''/\epsilon_0}{60 \lambda_0} [\text{ohm}^{-1} \text{ m}^{-1}]$$

with  $\lambda_0$  representing the vacuum wavelength in [cm] or [m] .

The attenuation produced by a dielectric material may be expressed by the distance  $1/\beta$ , over which the fieldstrength decays to  $1/e = 0.368$  of its original value

$$(8) 1/\beta = \frac{\lambda_0}{2\pi} \sqrt{\frac{2}{\frac{\epsilon' \mu}{\epsilon_0 \mu_0} (\sqrt{1 + \tan^2 \delta} - 1)}}$$

The charts, fig. 3-5, give this attenuation distance in meters for a range of  $\tan \delta$  from 0.0001 to 100.

It is more common to describe the attenuation encountered by the number of decibels produced by a given length  $x$  of the material:

$$(9) 20 \log \frac{E(0)}{E(x)} = 8.686\beta x [\text{decibels}].$$

The charts, fig. 6-8, give the attenuation in decibels per meter over the same range of  $\tan \delta$  as above.

Equation (9) simplifies for low loss material ( $\tan \delta \ll 1$ ) to:

$$(9a) 20 \log \frac{E(0)}{E(x)} = 8.686\pi \tan \delta \frac{x}{\lambda} [\text{decibels}]:$$

the wavelength  $\lambda$  in the dielectric is, in this case, determined by vacuum wavelength and real dielectric constant alone:

$$(10) \lambda = \frac{\lambda_0}{\sqrt{\frac{\epsilon' \mu}{\epsilon_0 \mu_0}}}$$

Thus the well-known formula results for db/ft of low loss dielectrics:

$$(11) \text{Attenuation} = 8.3 \sqrt{\frac{\epsilon'}{\epsilon_0}} \tan \delta \frac{1}{\lambda_0} [\text{decibels per foot.}]$$

The charts, fig. 9-10, serve to obtain the index of refraction and the index

of absorption for material of medium loss only, because for low and high loss material, simple approximation equations exist:

$$\text{Low Loss (12) } n = \sqrt{\frac{\epsilon' \mu}{\epsilon_0 \mu_0}} \quad \kappa = \frac{\tan \delta}{2}$$

$$\text{High Loss (13) } n = \sqrt{\frac{1}{2} \frac{\epsilon'' \mu}{\epsilon_0 \mu_0}} \quad \kappa = 1$$

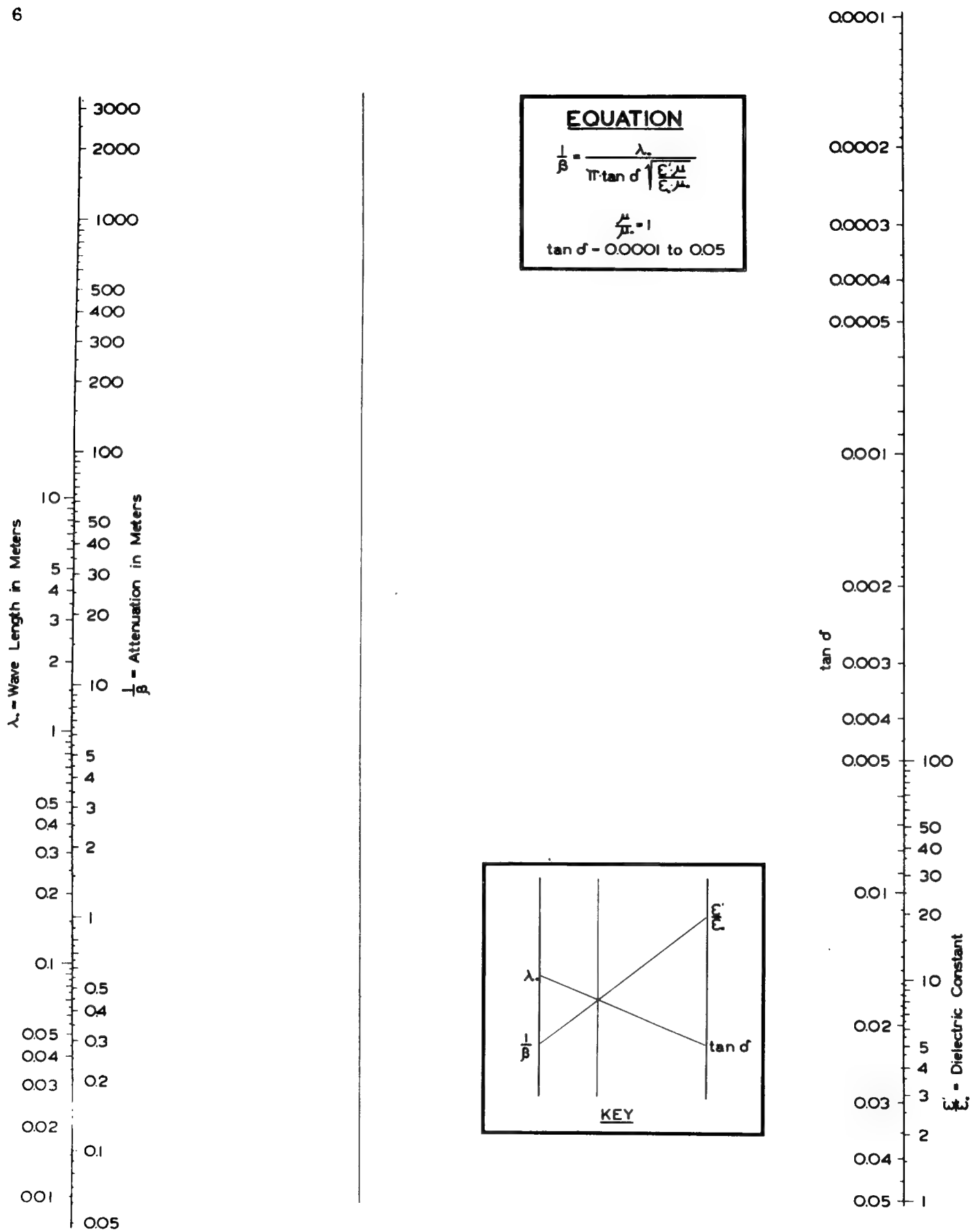


fig. 3

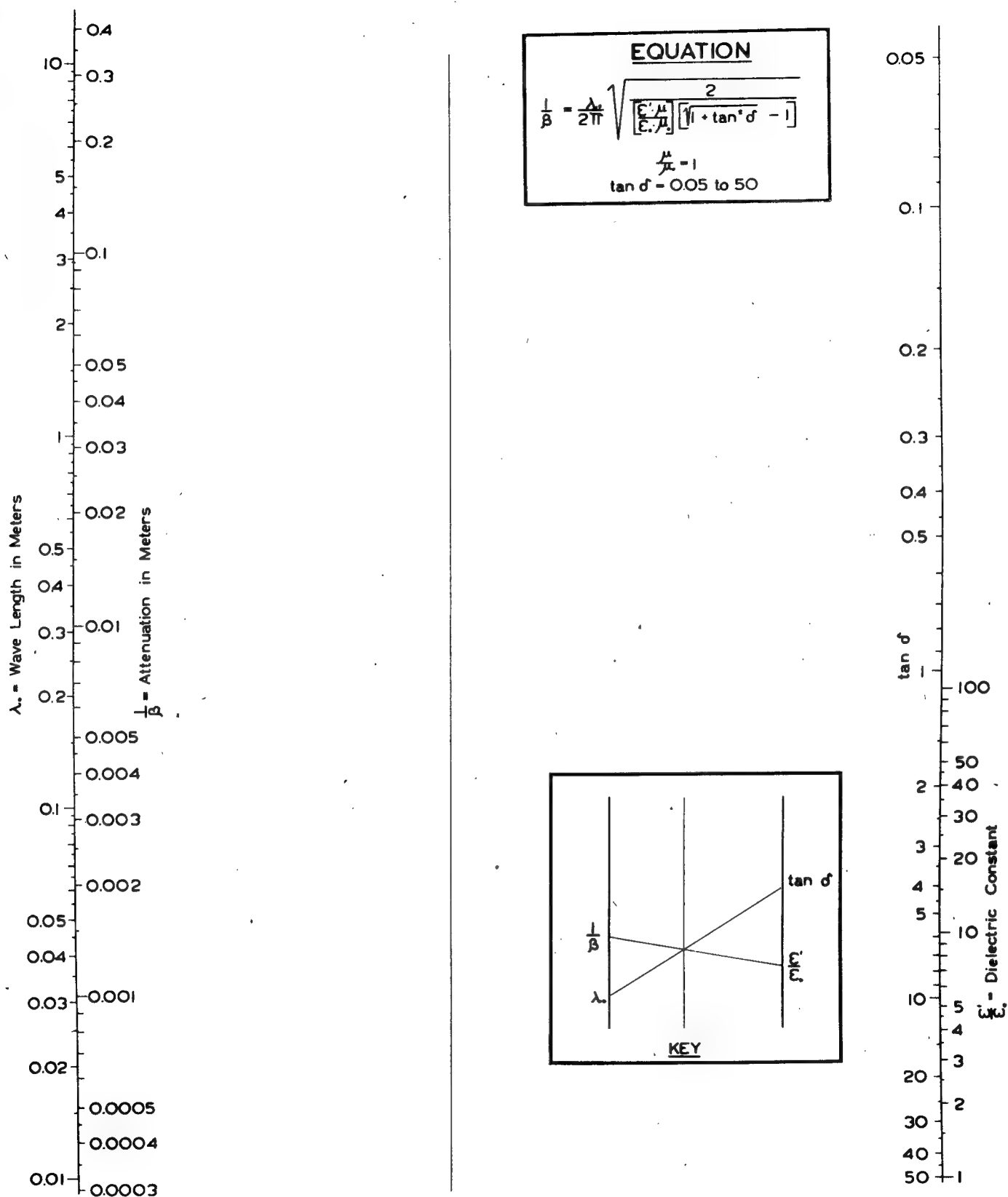
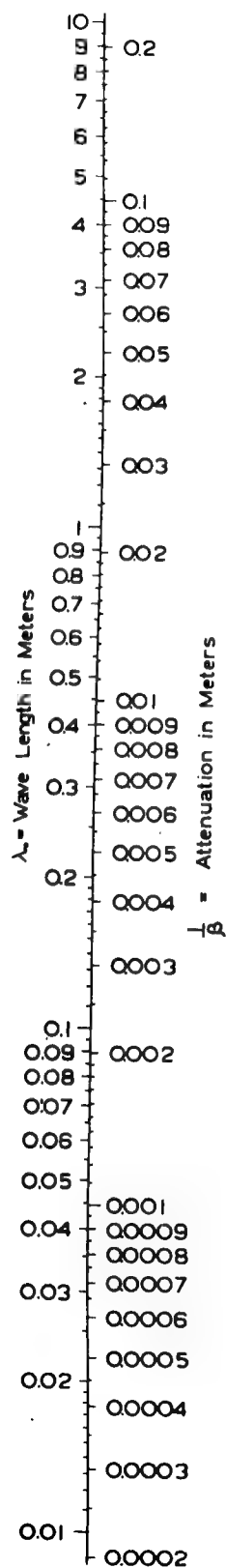


fig. 4



**EQUATION**

$$\frac{1}{\beta} = \frac{\lambda_w}{2\pi} \sqrt{\left[ \frac{\epsilon_r \mu_r}{\epsilon_r \mu_r} \right]^2 \tan^2 \delta}$$

$\mu_r = 1$   
 $\tan \delta = 50 \text{ to } 100$

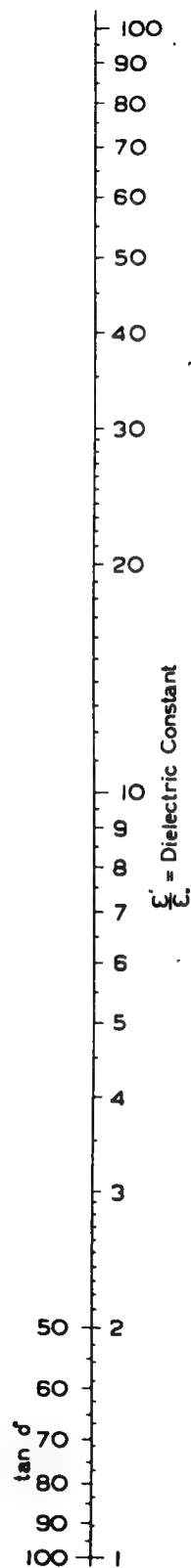
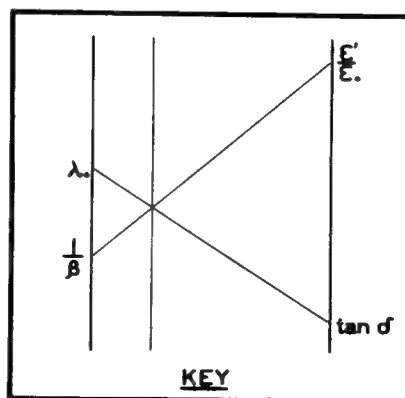
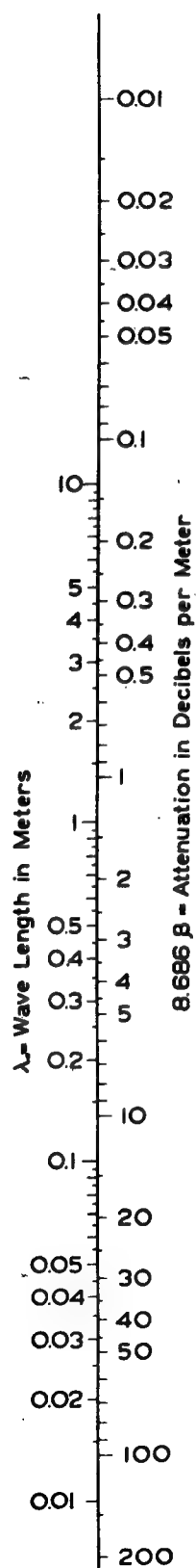


fig. 5



**EQUATION**

$$8.686 \beta = \frac{8.686 \pi \tan \delta'}{\lambda} \sqrt{\frac{\epsilon_r \mu_r}{\epsilon_0 \mu_0}}$$

$\frac{\mu_r}{\mu_0} = 1$

$\tan \delta' = 0.0001 \text{ to } 0.05$

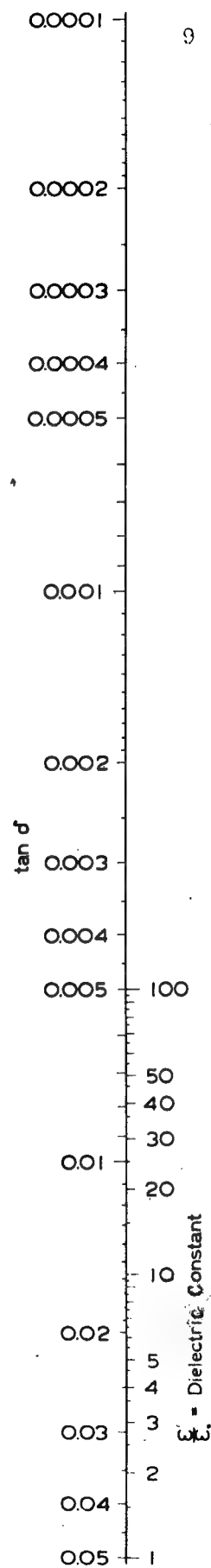
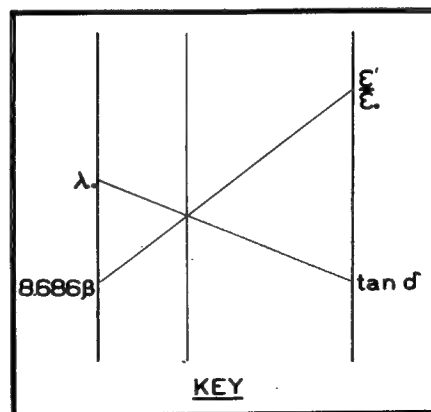


fig. 6

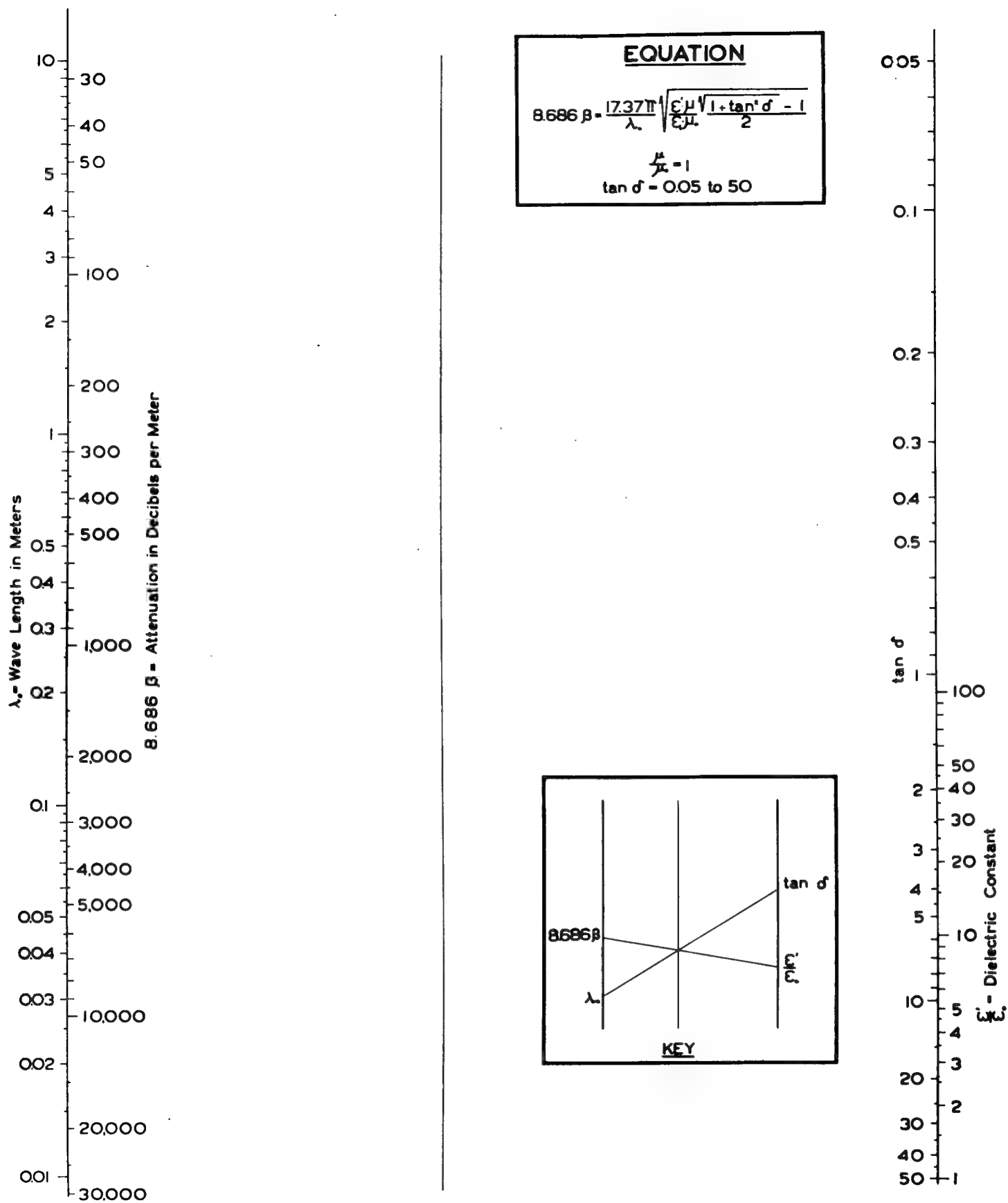


fig. 7

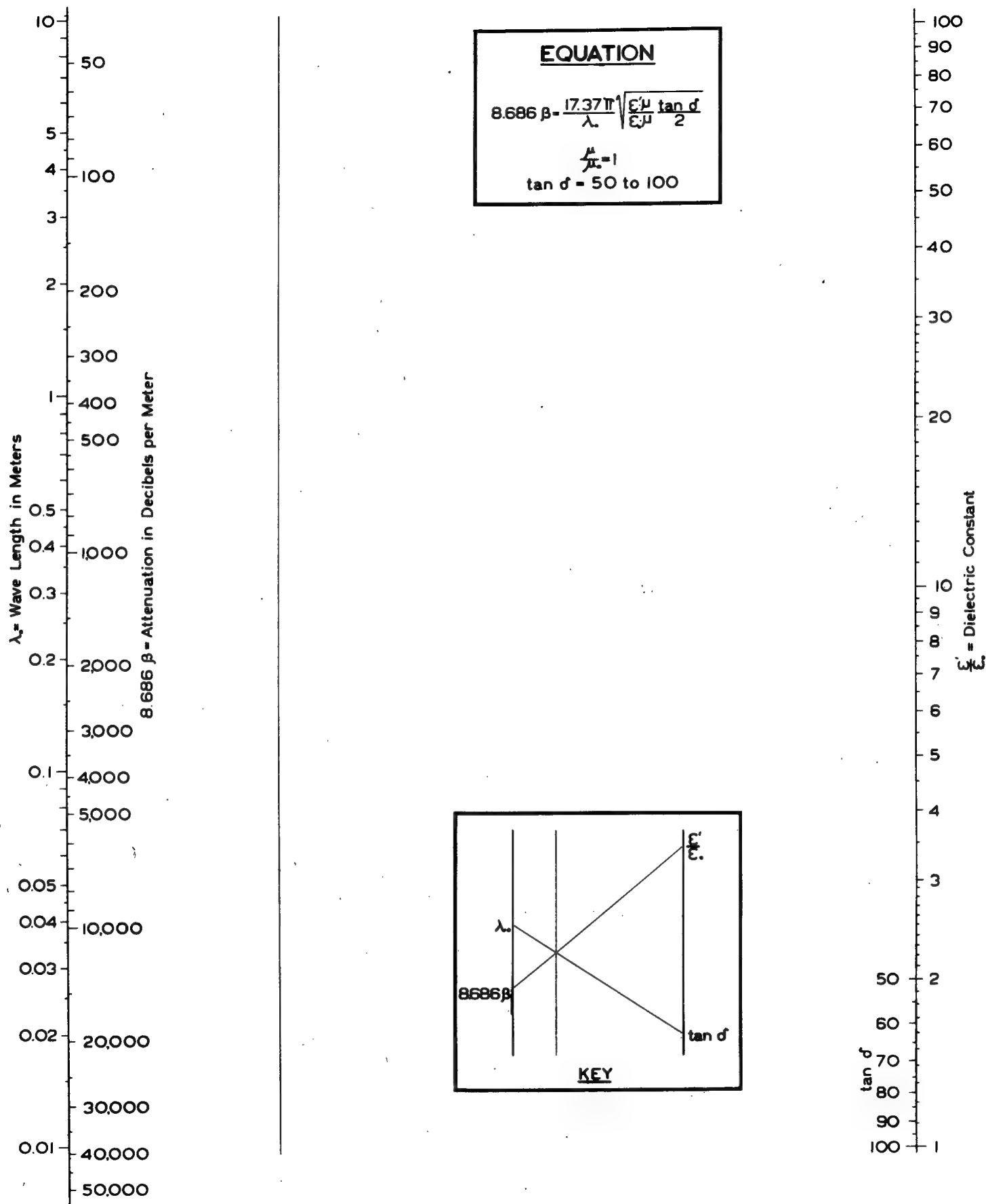
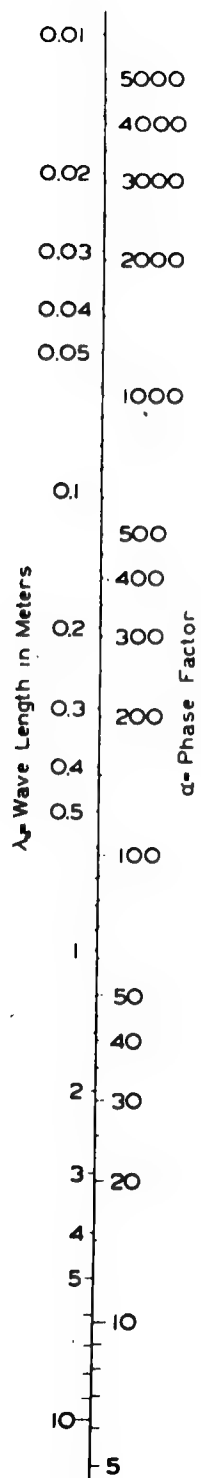


fig. 8





**EQUATION**

$$\alpha = \frac{2\pi}{\lambda_w} \sqrt{\frac{\epsilon_r \mu_r}{\epsilon_0 \mu_0} \left[ \frac{1 + \tan^2 \delta}{2} \right]}$$

$\frac{\mu_r}{\mu_0} = 1$   
 $\tan \delta = 0 \text{ to } 50$

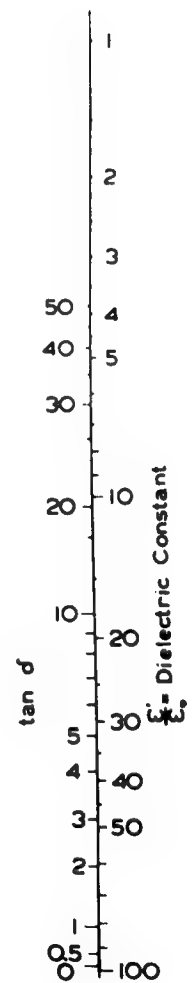
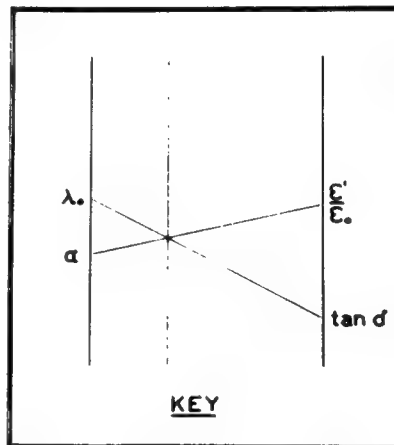


fig. 9

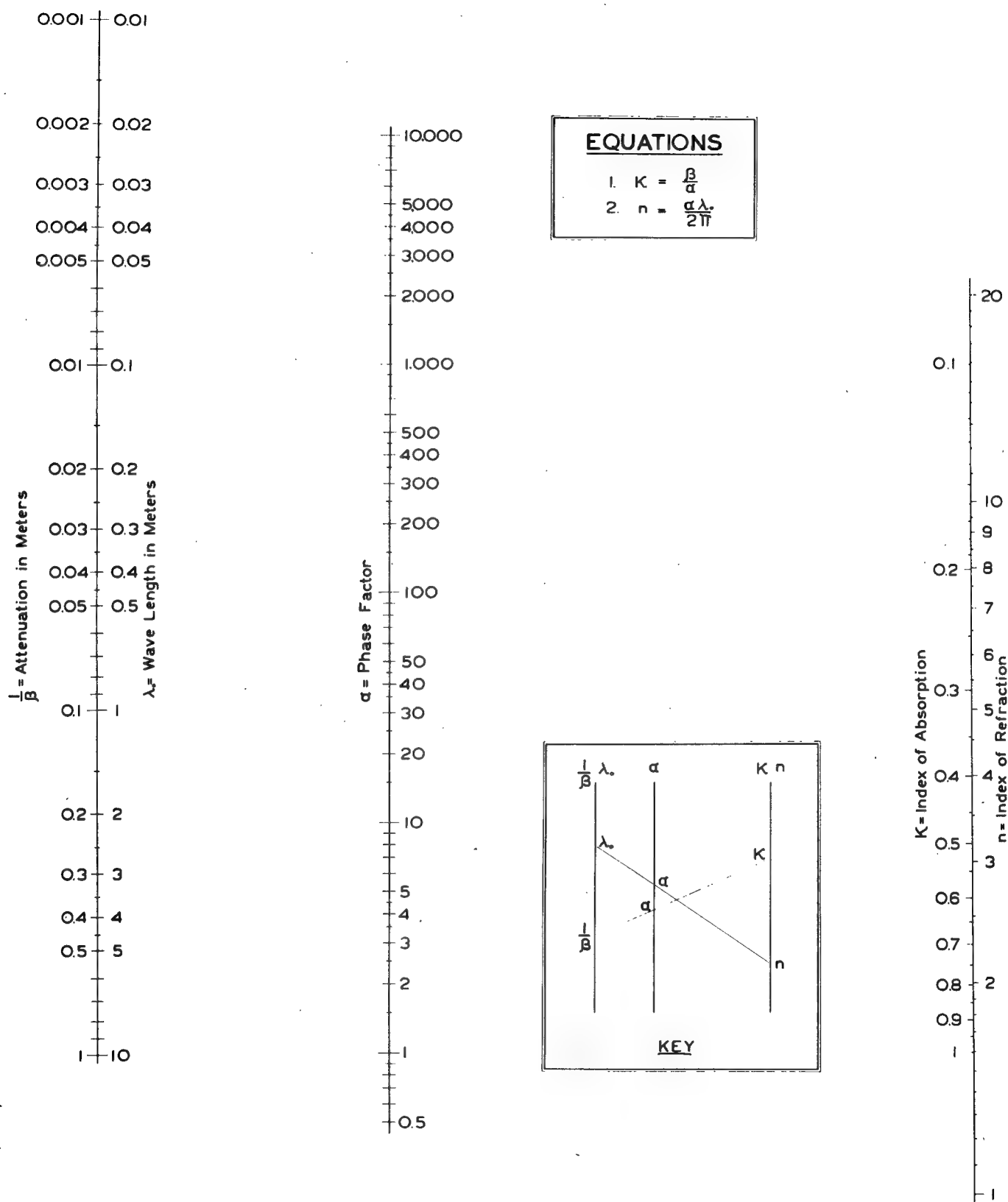


fig. 10

### Origin of Dielectric Polarization.

Polarization is the response of the charge carriers in a dielectric to an applied electric field. These carriers may be locally bound, such as electron clouds compensating the charge of nuclei, or ions forming crystal structures. An exterior field in this case displaces slightly the positive against the negative charge carriers, thus inducing dipole moments by "electronic" or "atomic" polarization (fig. 11). This "induced" polarization has its resonance frequencies in the optical spectral range. It therefore builds up instantaneously in the electrical frequency range, thus producing no loss but contributing a frequency-independent "optical" dielectric constant  $\epsilon'_{\infty}$ .

In addition to these induced dipoles, there exist in many molecules permanent dipoles produced by the difference in electron affinity of their atoms. Such dipoles tend to produce polarization by "orientation" of the molecules in the field applied (fig. 12). Molecules, freely rotating as in gases, follow the field more or less instantaneously; the resonance frequencies are found in the infra-red but for heavy molecules extend into the microwave range. In liquids and solids, however, the freedom of rotation is normally impeded by the interaction of the neighboring molecules. The resonance phenomenon degenerates into an aperiodic orientation under high friction, which is very temperature-sensitive.

The effect of this dipole-orientation polarization appears very pronounced in many of our frequency characteristics. Its principle feature is that with increasing frequency, the dipoles begin to lag more and more behind the field; that is, their contribution to the dielectric constant decreases. Simultaneously, the loss tangent or power factor begins to increase, goes through a maximum and decreases again as the dipole effect dies out. If only one dipole

## Effect of External Field on a Dielectric Medium

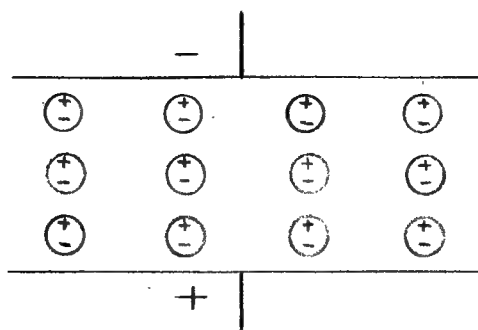


fig. 11

## Forces on a Dipolar Molecule

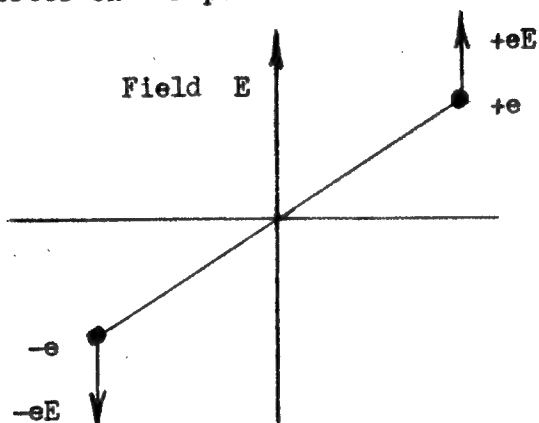


fig. 12

## Dielectric Parameters for Dipole - Orientation Polarization

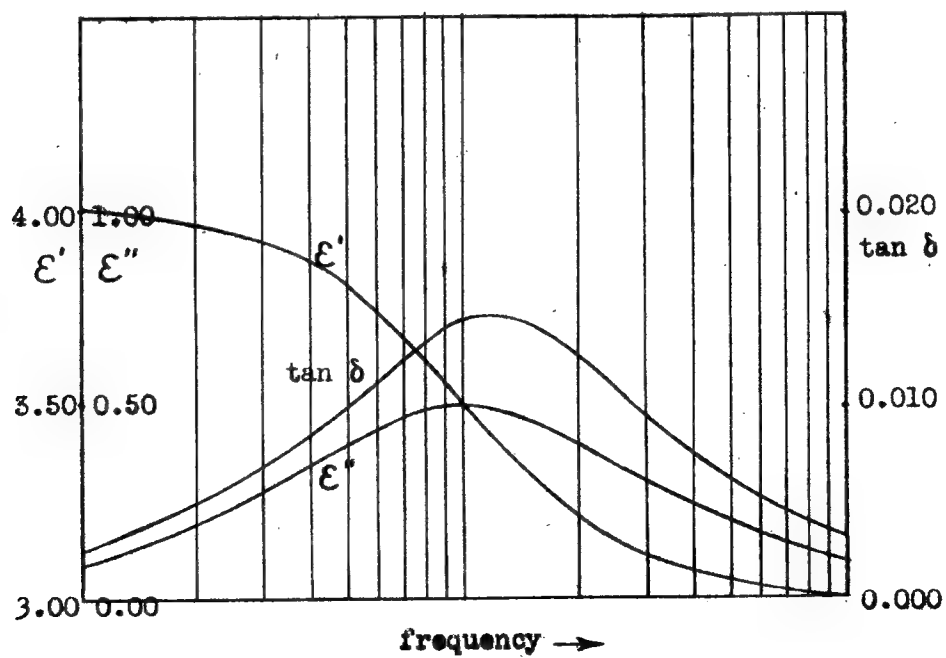


fig. 13

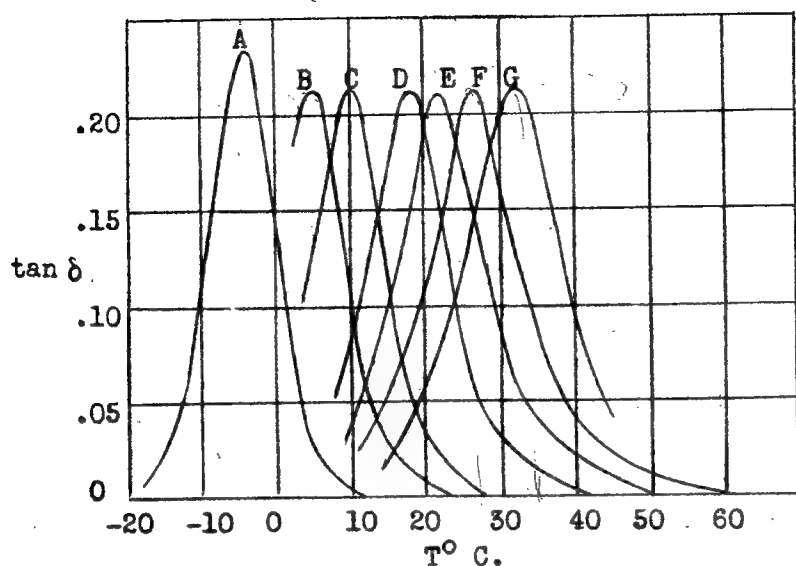
type is present, orientating itself in a viscous medium without mutual interaction, the electrical behavior of the dielectric can be represented by a simple RC circuit. After removal of the field, the polarization would die down exponentially with a "relaxation time"  $\tau$ ; and, as function of frequency, the dielectric parameters would change as indicated in fig. 13. With increasing temperature, the viscosity decreases, the relaxation time shortens and the whole dispersion phenomenon moves to higher frequencies (fig. 14).

In practice, most dielectrics do not act as simply as this picture visualizes. Particularly in plastics, each dipole finds itself in slightly different surroundings, thanks to the varying location of neighboring molecules. Thus a wide distribution of relaxation times exists, flattening out the decay characteristic of  $\epsilon'$  and the hump of the dielectric absorption.

Besides this localized polarization produced by dipoles, there exists a "space charge" polarization created by the migration of charge carriers. If electrons or ions migrate unimpeded through a material, a frequency-independent conductivity results. This is represented in the loss characteristic by a loss tangent decaying inversely proportional to the frequency (fig. 15). If the charge carriers, after migrating over some distance are stopped, as, for instance, on the grain boundary of a carbon particle embedded in rubber, a field distortion results. To the outside observer, this gives the impression of a high dielectric constant (fig. 16). Dielectric constant and loss in this case are frequency dependent and influenced fundamentally by the nature and distribution of the conducting particles (fig. 17).

Moisture absorption can very strongly affect the dielectric properties of a material. As fig. 18 indicates, water itself shows in the fre-

## Dielectric Losses in Pyranol



(After Jackson)

fig. 14

## Dielectric Loss Produced By Conduction

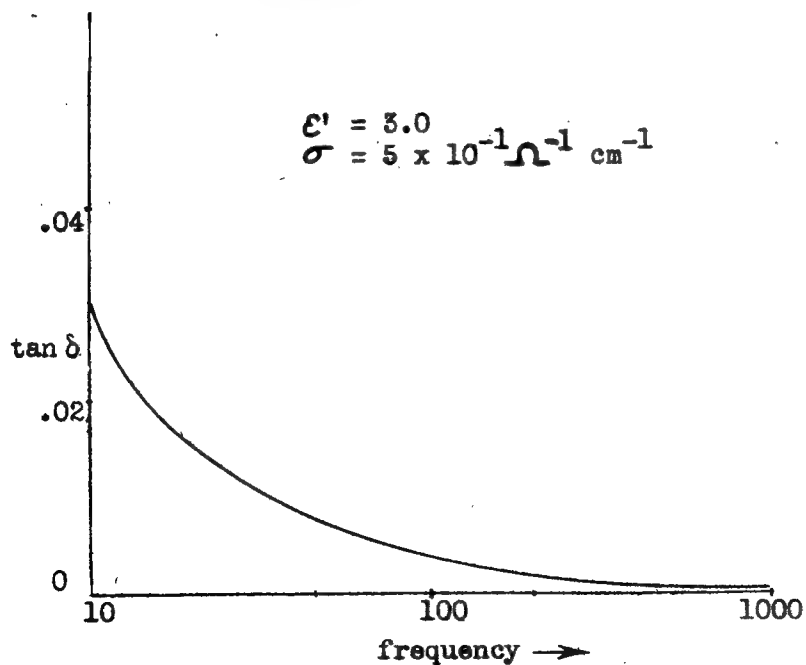


fig. 15

## Three Layer Mixed Dielectric

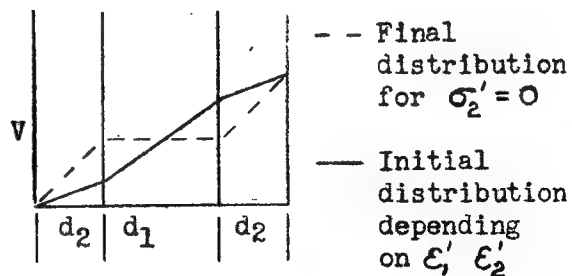
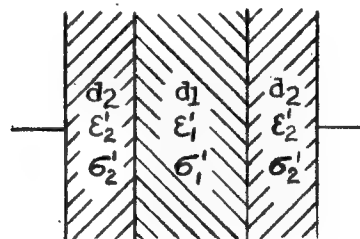
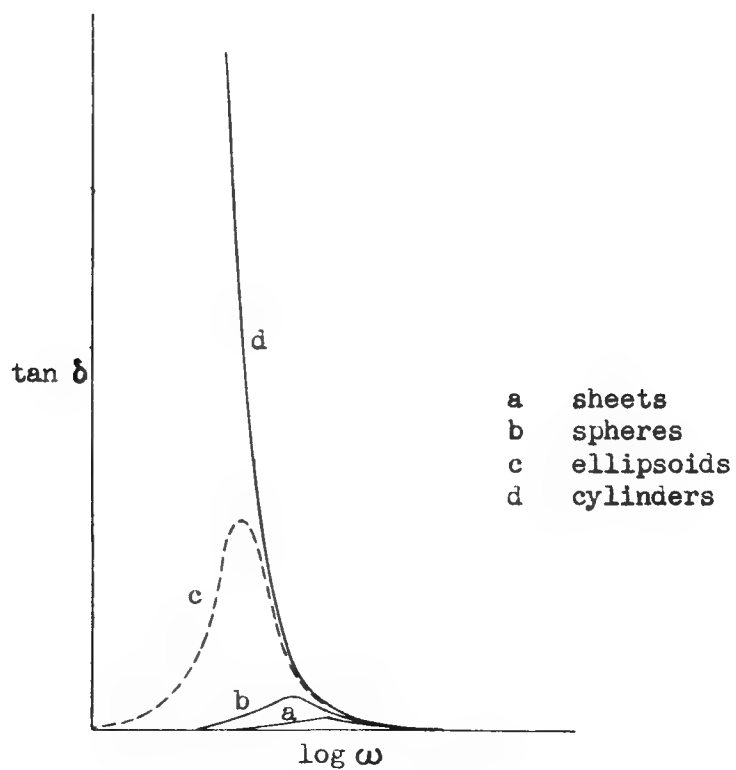
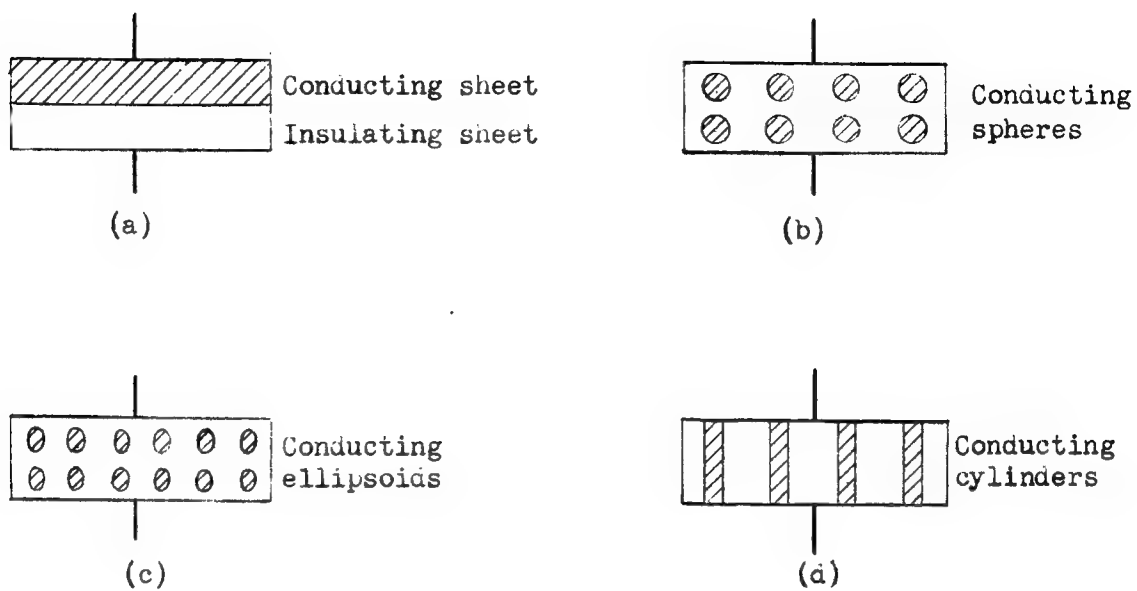


fig. 16

Loss Tangent Produced by a Given Quantity  
of Conducting Material Imbedded in a Dielectric



(After Sillars)

fig. 17

quency range up to about 10 megacycles the decreasing loss characteristic of conductivity (compare fig. 15). Above this frequency, the dipole characteristic of the water molecule begins to dominate, the loss tangent again rises and will reach its maximum at room temperature above  $3 \times 10^{10}$  cycles. Simultaneously, the dielectric constant drops to about half of its original value. This double nature of water may not become always apparent if it is absorbed or adsorbed in other dielectric materials. It may, however, have very disturbing effects. A special investigation of the influence of moisture is needed for a wide variety of materials and will be undertaken in our laboratory at an early date.

The reader will find that the effects just discussed make the general trend of the different dielectric characteristics well understandable. An accurate analysis of the characteristics is contemplated for a later edition of these "Tables".



## DIELECTRIC PROPERTIES OF CONDUCTIVITY WATER

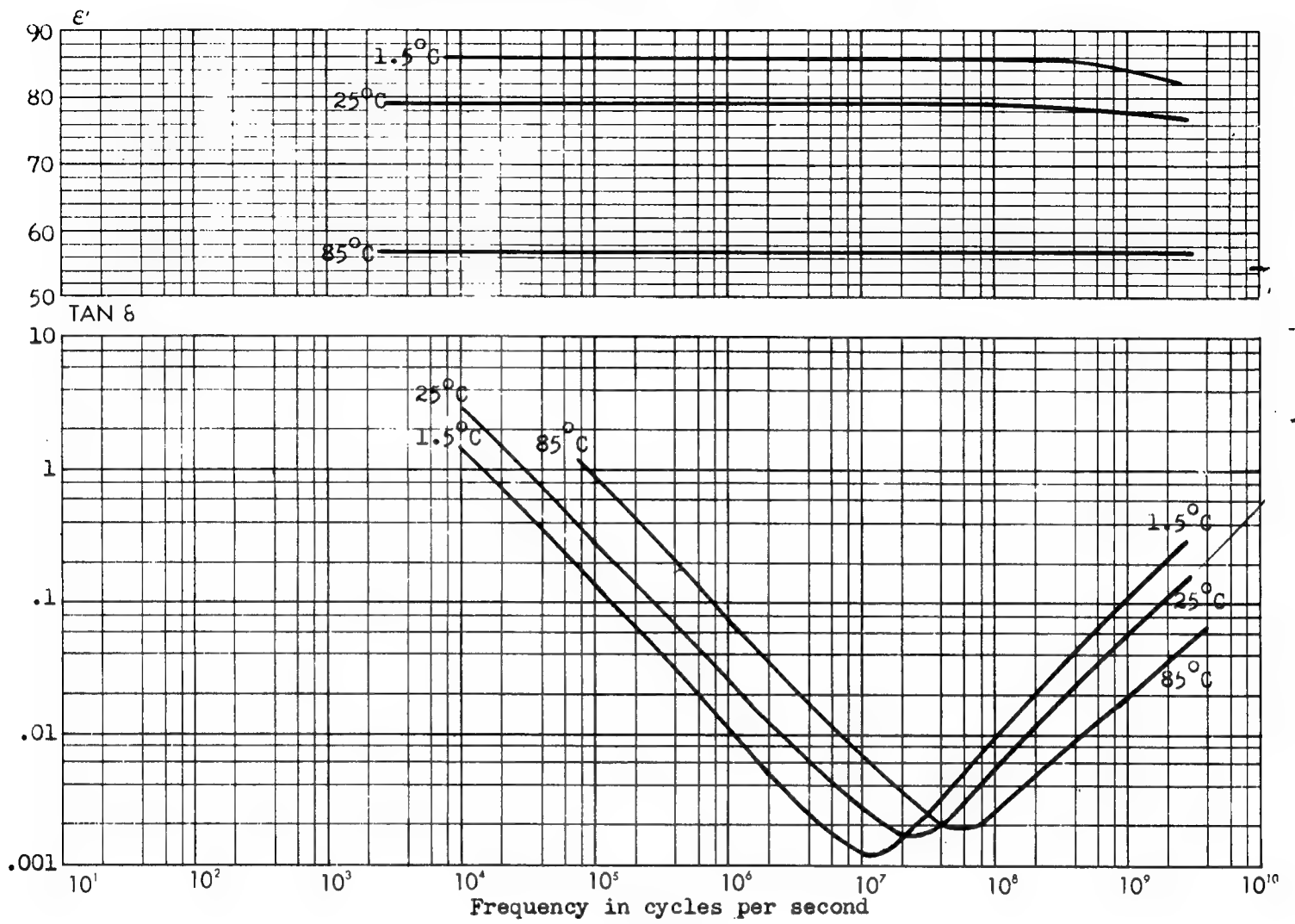


fig. 18

Accuracy of Dielectric Constant and Loss Data

The graphs of  $\epsilon'$  versus frequency at room temperature are believed to be accurate within 2% over the entire frequency range except for very high loss samples ( $\tan \delta > .1$ ) or high constant samples ( $\epsilon' > 5$ ) at frequencies above 100 megacycles. Elevated temperature runs are believed to be accurate within 3%. In most cases where the measured change in  $\epsilon'$  with temperature is less than 2%, the two curves are combined to show no change.

The graphs of  $\tan \delta$  versus frequency are believed to be accurate within 5% for most medium loss samples ( $0.002 < \tan \delta < 0.1$ ) over the entire frequency range at both room temperature and elevated temperatures. Graphs showing a rapid change in loss in the 100 megacycle to 1,000 megacycle region may be somewhat less accurate in this region. For most high loss samples the accuracy is better than 10%. Arrows shown on the graphs of low loss samples indicate the maximum possible values of loss at particular frequencies, the lower limit in these cases being zero. Few arrows are used for 3,000 megacycle values where the sensitivity of measurement is highest; here values are accurate to 0.00005 for most low loss samples.

ABBREVIATIONS

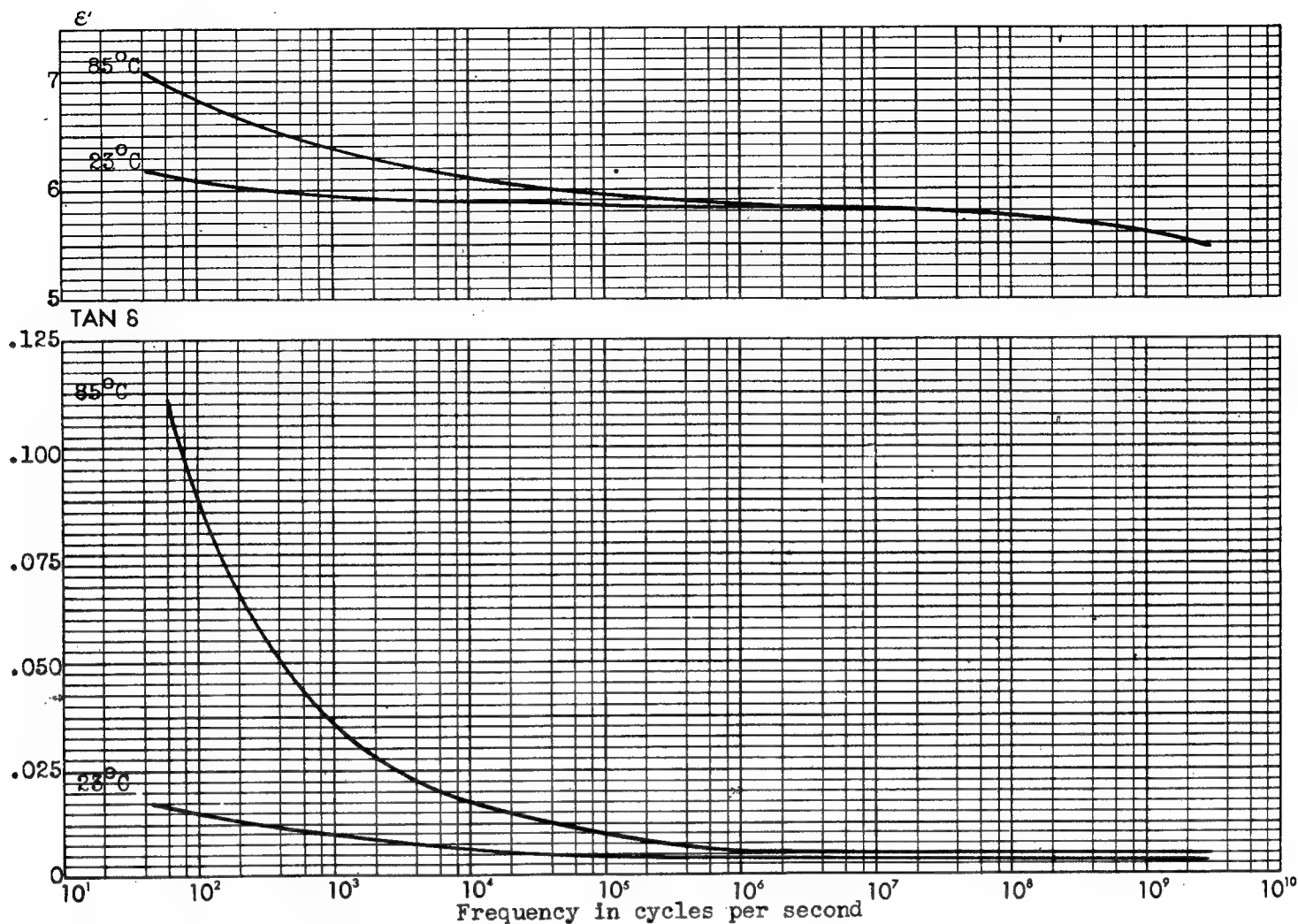
<u>Property</u>	<u>Units</u>	<u>Test Method</u>	<u>Abbreviations</u>
Acid Value	mgm.KOH/gm. sample	D663-42T	Ac. Val.
Annealing Point	°C		T <sub>ann.</sub>
Arc Resistance	sec.	D495-42	Arc Res.
Boiling Point	°C	D86-40 e.g.	B. P.
Brittle Point	°C		T <sub>br.</sub>
Casting			Cast.
Chemical Resistance		D543-41T e.g.	Chem. Res.
Compression Molding			Compr. Mold.
Compressive Strength	lbs./in. <sup>2</sup>	D116-34 D695-42T	Comp. Str.
Deformation Under Load	%	D621-41T	Def. Load
Density	gm./cm. <sup>3</sup> at T°C	D71-27	d <sup>T</sup>
Dielectric Constant	ε' air=1	(Schering ( Bridge	ε'
Dielectric Loss Tangent		(Susceptance ( Variation ( Standing ( Wave	tan δ
Electrical Strength	volts/mil	D149-40T	Elec. Str.
Elongation	%	D674-42T	Elong.
Extrusion			Extr.

ABBREVIATIONS

<u>Property</u>	<u>Units</u>	<u>Test Method</u>	<u>Abbreviations</u>
Flammability	sec. in. <sup>2</sup> /min. in./min.	D229-42 D568-41T D635-41T	Flam.
Fire Point	°C	D92-33	Fire P.
Flash Point	°C	D93-42 e.g.	Flash P.
Flexural Strength	lbs./in. <sup>2</sup>	(D671-42T (D650-42T	Flex. Str.
Hardness - Brinell		E10-27	Brinell
Hardness	Mohs' scale		Mohs' scale
Hardness - Penetrometer	mm.	D217	Penetrometer
Hardness - Rockwell		E18-43	Rockwell
F 1/16" ball	100 Kg. Load	Red Scale	
H 1/8" ball	60 Kg. Load	Red Scale	
L 1/4" ball	60 Kg. Load	Red Scale	
M 1/4" ball	100 Kg. Load	Red Scale	
R 1/2" ball	60 Kg. Load	Red Scale	
Y 1/2" ball	15 Kg. Load	Red Scale	
Hardness - Shore			Shore
Heat Distortion	°C	D648-41T	T <sub>dis.</sub>
Heat of Fusion	cal./gm.		Heat Fus.
Heat of Vaporization	cal./gm.		Heat Vap.
Impact Strength - Charpy	ft. lbs./in. <sup>2</sup>	D256-41T	Imp.(Charpy)
Impact Strength - Izod	ft. lbs./in. <sup>2</sup>	D256-41T	Imp.(Izod)
Injection Molding			Inj. Mold.
Light Transmission	%	D672-42T e.g.	Light Trans.
Machining Quality			Mach.
Melting Point	°C	D87-42 e.g.	M. P.

ABBREVIATIONS

<u>Property</u>	<u>Units</u>	<u>Test Method</u>	<u>Abbreviations</u>
Modulus of Elasticity	lbs./in. <sup>2</sup>	E8-36	Mod. El.
Moisture Absorption	%	D570-42	Moist. Abs.
Polymerizability			Poly
Saponification Value	mgm KOH/gm. sample	D94-39T	Sap. Val.
Shearing Strength	lbs./in. <sup>2</sup>	D638-42T	Shear. Str.
Softening Point	°C	E28-42T	T <sub>soft.</sub>
Solubility			Sol.
Specific Heat	cal./gm.		Spec. Heat
Sunlight - Effect of		D620-41T e.g.	Sun.
Surface Resistivity	ohm	D257-38	Surf. Res.
Surface Tension	dynes/cm.		Surf. Tens.
Temperature	°C		T.
Tensile Strength	lbs./in. <sup>2</sup>	(D638-42T (D651-42T	Ten. Str.
Thermal Conductivity	cal./cm. <sup>2</sup> / sec./°C/cm.	D325-31T	Therm. Cond.
Thermal Expansion, Linear coefficient of	parts/°C	D696-42T	Therm. Exp.
Thermal Shock Resistance	cycles	D116-39 e.g.	Therm. Shock Res.
Thermal Stability	°C		Therm. Sta.
Toxicity			Tox.
Viscosity	centipoises	D446-39	Visc.(cp.)
Viscosity	centistokes	D445-24T	Visc.(cs.)
Viscosity	Saybolt sec.	D88-38	Visc.(sec.)
Volume Resistivity	ohm cm.	D257-38	Vol. Res.



**Composition:** Magnesium silicate (Steatite ceramic)

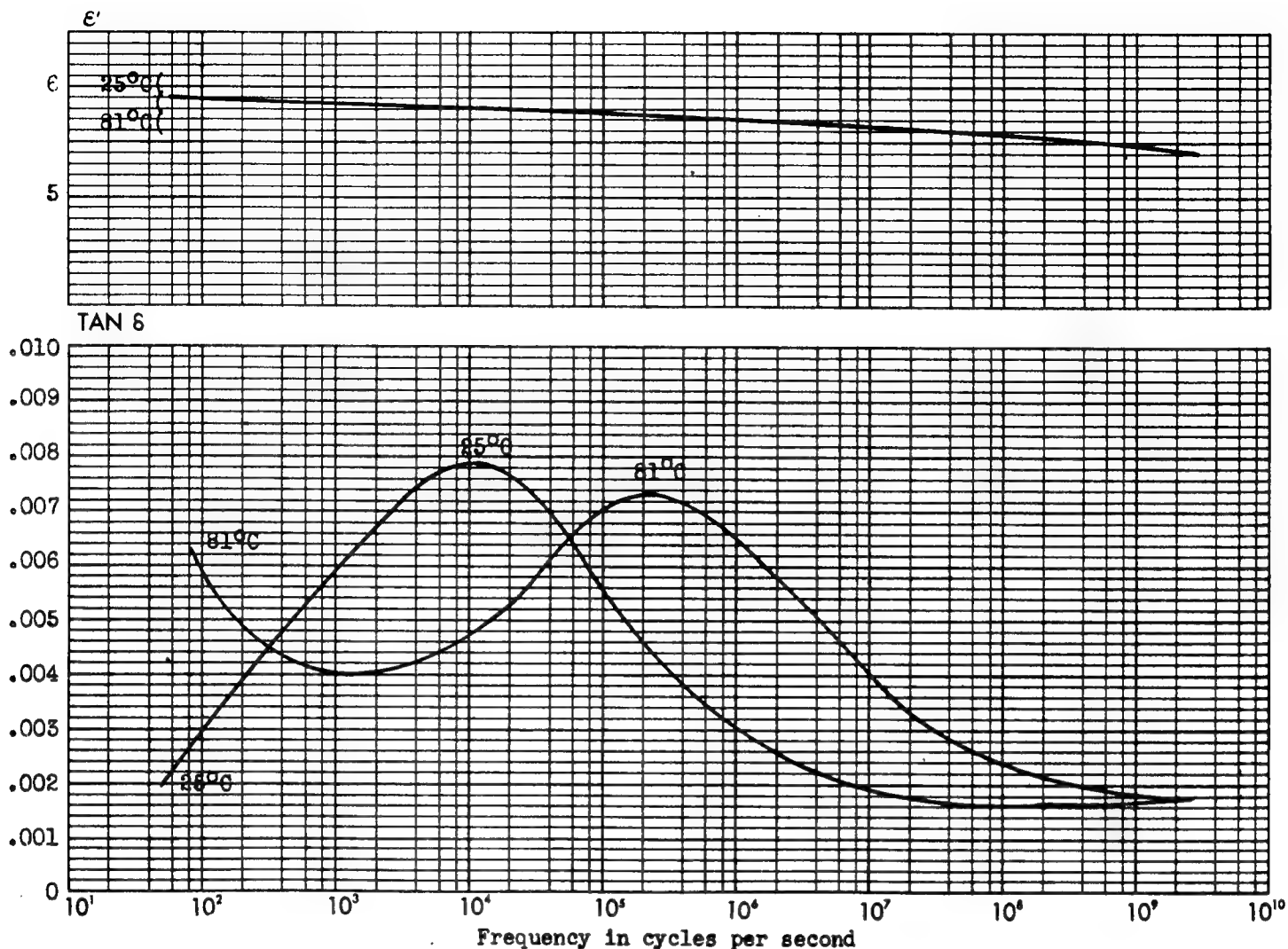
**Firing Conditions:** Cone 14, approx. 1410°C.

**Properties:** Cream-white.  $d^{25}=2.6$ . Ten. Str. 8500. Imp.(Charpy) 1.8. Comp. Str. 75,000. Flex. Str. 20,000. Mohs' scale 7. Therm. Exp. 20-100°C,  $6.9 \times 10^{-6}$ ; 20-600°C,  $8.7 \times 10^{-6}$ . Therm. Cond. 0.006.  $T_{\text{soft}}$  1450°C. Therm. Sta. 1000°C. Res. Therm. Shock: 20 or more cycles boiling to ice-water for rod 3/4" dia. x 6". Chem. Res.: acids, excellent except HF; alkalies, excellent; water, excellent; steam, good to 10 psi. Moist. Abs. < .1%. Elec. Str. 225 (1/4" thick). Vol. Res.  $> 10^{14}$ . Seals to Corning G12.

**Methods of Handling:** Dry pressing, extrusion and slip casting possible.

**Recommended Uses:** An all purpose steatite ceramic material which has been approved as Class L3 insulating material (Am. War Std. C75.1-1943).

**Availability:** Commercially available, glazed and unglazed in shapes and sizes to specifications.



Composition: Magnesium silicate (Steatite ceramic)

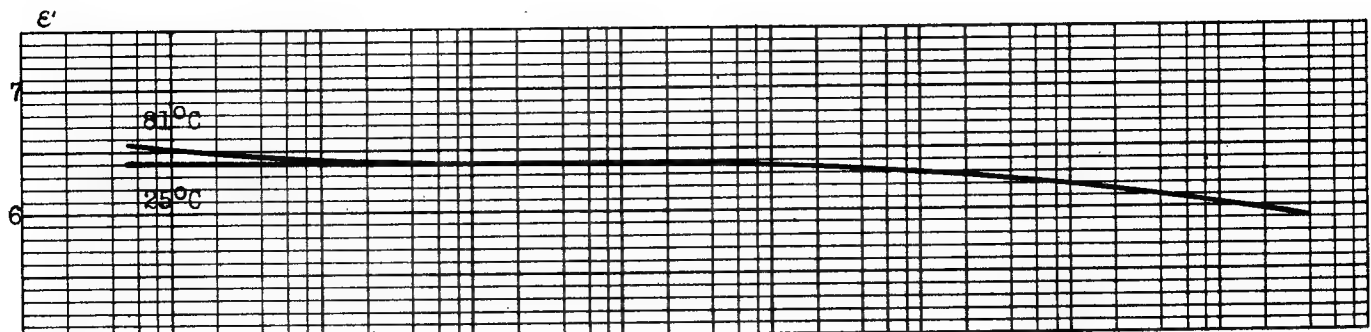
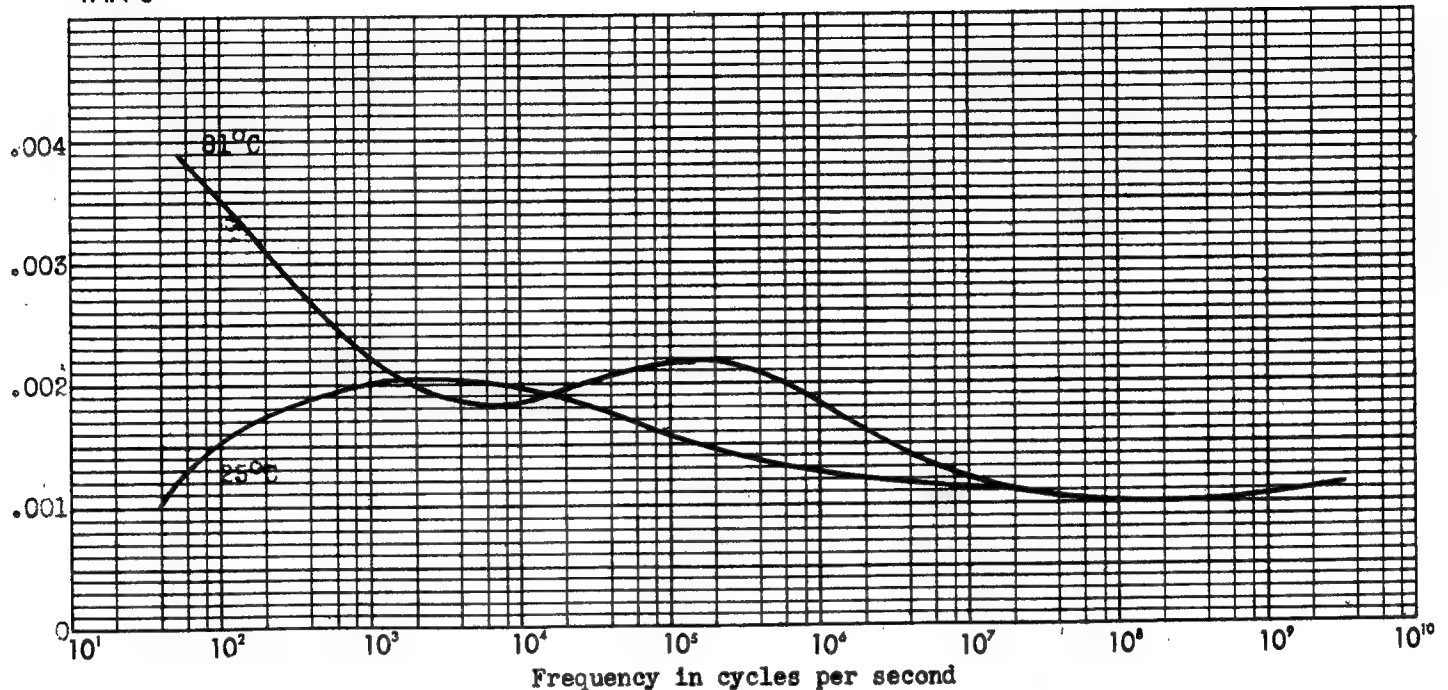
Firing Conditions: Cone 14 ( $1410^\circ\text{C}$ ).

Properties: Grey-white.  $d_{25}^{25}=2.7$ . Ten. Str. 10,000. Imp.(Charpy) 2.1. Comp. Str. 85,000. Flex. Str. 22,000. Mohs' scale 7. Therm. Exp.:  $20-100^\circ\text{C}$   $7.3 \times 10^{-6}$ ;  $20-600^\circ\text{C}$   $8.9 \times 10^{-6}$ .  $T_{\text{soft}}$   $1450^\circ\text{C}$ . Therm. Sta.  $1000^\circ\text{C}$ . Res. Therm. Shock: 20 or more cycles boiling to ice-water for rod  $3/4"$  x  $6"$ . Chem. Res.: acids, excellent except HF; alkalis, excellent; water, excellent; steam, good to 10 psi. Moist. Abs.  $\leq 0.1\%$ . Elec. Str. 240 ( $1/4"$  thick). Vol. Res.  $> 10^{14}$ . Seals to Corning G12.

Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: A steatite ceramic material for high frequency insulation which has been approved as Class L-4 material under Am. War Std. C75.1-1943.

Availability: Commercially available, glazed and unglazed in shapes and sizes to specifications.

TAN  $\delta$ 

Composition: Magnesium silicate (Steatite ceramic)

Firing Conditions: Cone 14, approx. 1410°C.

Properties: Light gray to white.  $d^{25}=2.7$ . Ten. Str. 10,000. Comp. Str. 80,000. Flex. Str. 20,000. Mohs' scale 7.5. Therm. Exp. 20-600°C,  $6-8 \times 10^{-6}$ .

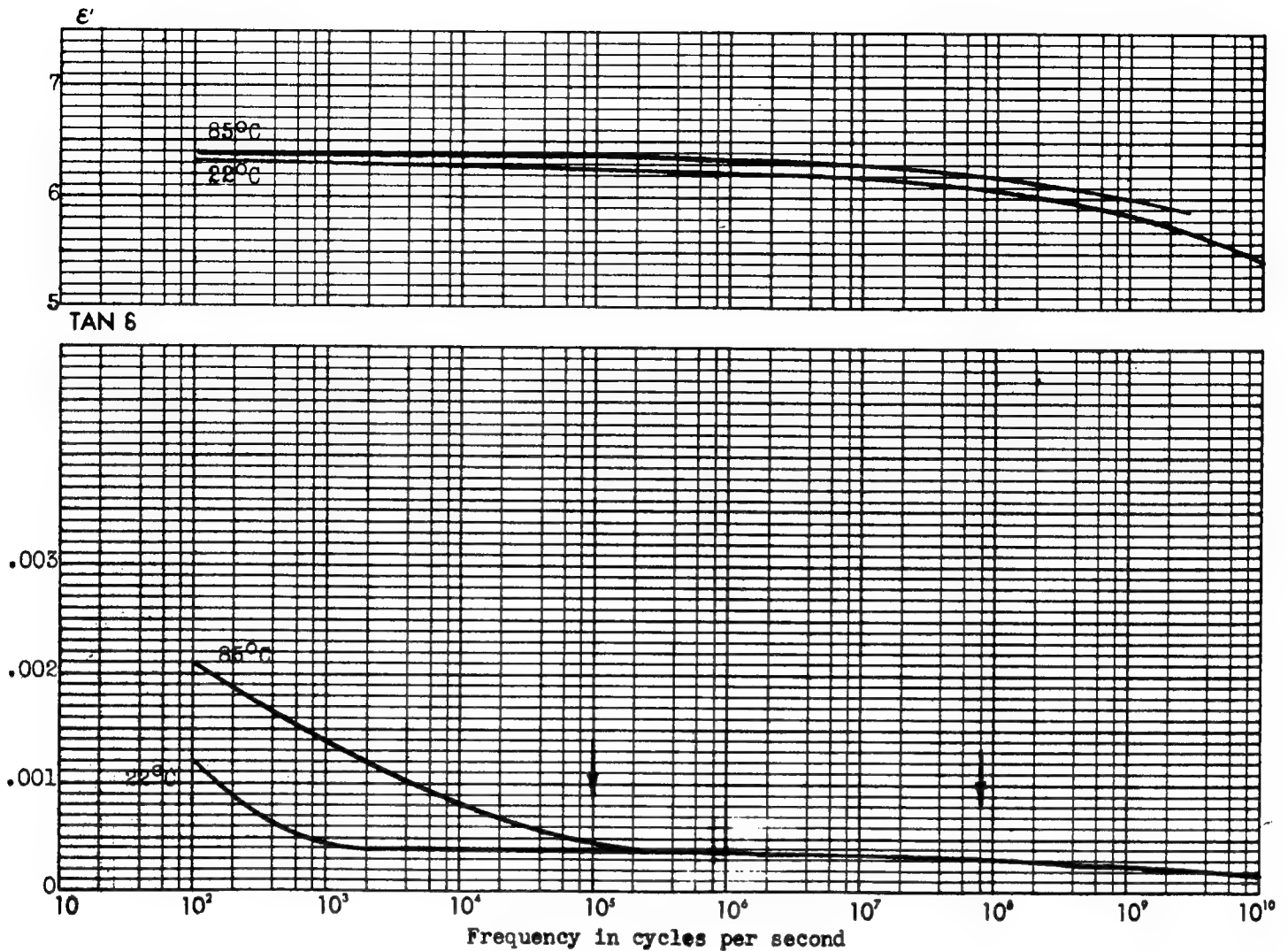
$T_{\text{soft}}$  1450°C. Therm. Sta. 1000°C. Res. Therm. Shock: 20 or more cycles boiling to ice water for .750" rods. Chem. Res.: acids, excellent except HF; alkalies, excellent; water, excellent; steam, excellent. Moist. Abs. <.05%.

Methods of Handling: Dry pressing, extrusion and slip casting possible. Fired on silver and soldering also possible.

Recommended Uses: All high frequency applications.

Availability: Available commercially in sizes and shapes to specifications.





Composition: Magnesium silicate (Steatite)

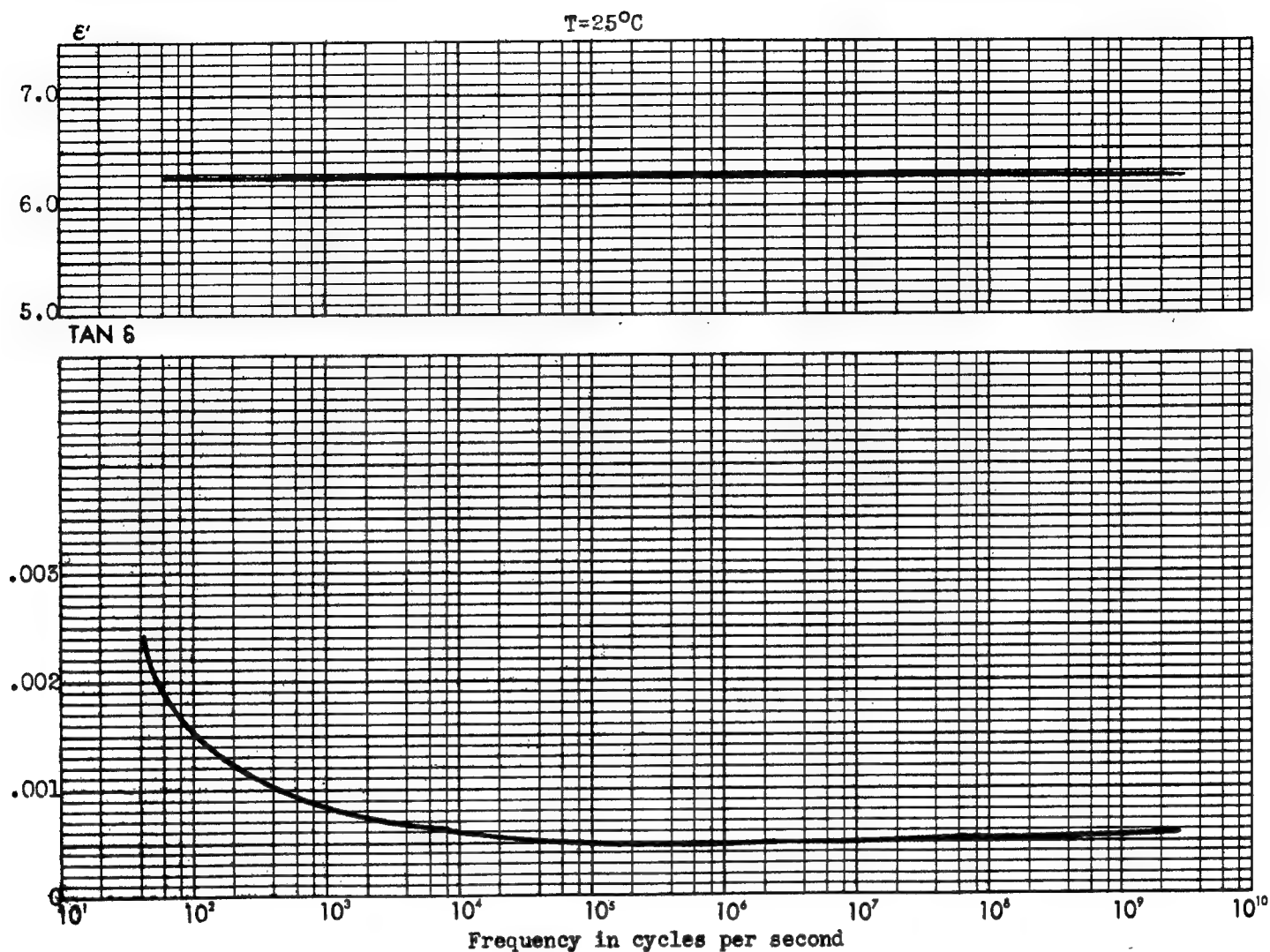
Firing Conditions: Cone 14, approx.  $1410^\circ\text{C}$ .

Properties: Cream.  $d^{25}=2.85$ . Ten. Sta. 7000. Comp. Str. 65,000. Flex. Str. 15,000. Mohs' scale 7. Therm. Exp.:  $20-100^\circ\text{C}$   $9.1 \times 10^{-6}$ ,  $20-650^\circ\text{C}$   $10.5 \times 10^{-6}$ .  $T_{\text{soft}} 1450^\circ\text{C}$ . Therm. Sta.  $1000^\circ\text{C}$ . Res. Therm. Shock: fair. Chem. Res.: acids, excellent except HF; alkalies, excellent; water, excellent; steam, good to 10 psi. Moist. Abs.  $<.1\%$ . Elec. Str. 200 (1/4" thick). Vol. Res.  $>10^{14}$  ohms.

Methods of Handling: Dry pressing and extrusion possible.

Recommended Uses: For all high frequency applications where L6 material according to Am. War Standards C75.1-1943 is required. Because of low dielectric loss at elevated temperature the material is also used for spacers in electronic tubes.

Availability: In sizes and shapes to specifications.



Chemical Name: Steatite ceramic.

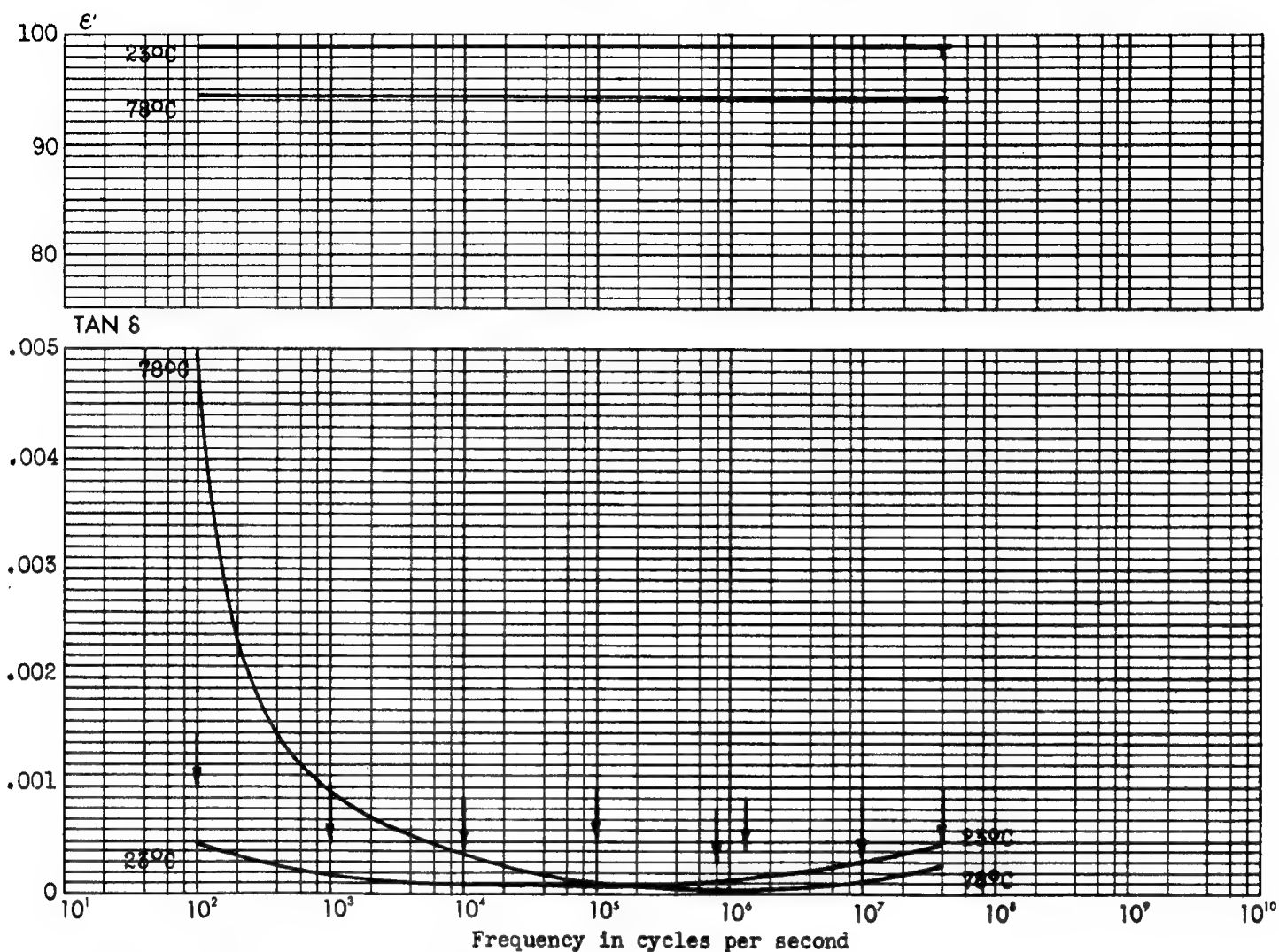
Composition: 48% sierramic talc, 32% Edgar plastic kaolin, 14% barium carbonate, 6% magnesium carbonate.

Properties: Cream, opaque. Machined before firing, ground or lapped after firing. Therm. Cond.  $5 \times 10^{-5}$ .  $T_{\text{dis}}$  1225°C.  $T_{\text{soft}}$  1275°C. Therm. Sta. 1000°C. Chem. Res.: acids, alkalis, solvents, water and oxygen, excellent. Sun.: none. Moist. Abs. <0.1%.

Methods of Handling: Compr. Mold.: at 8000; extrusion possible.

Recommended Uses: Low dielectric loss ceramic.

Availability: Experimental material.



Chemical Name: Titanium dioxide, rutile form.

Firing Conditions: Oxidizing, schedule firing to 1100°C-1350°C.

Properties: Cream, opaque.  $d^{25}=3.87$ . Therm. Sta.: refractory. Res. Therm. Shock: fair. Chem. Res.: acids, excellent except fuming  $H_2SO_4$  and HF; alkalis, excellent; water, excellent; steam, excellent.

Methods of Handling: Dry pressing, extrusion and slip casting possible.

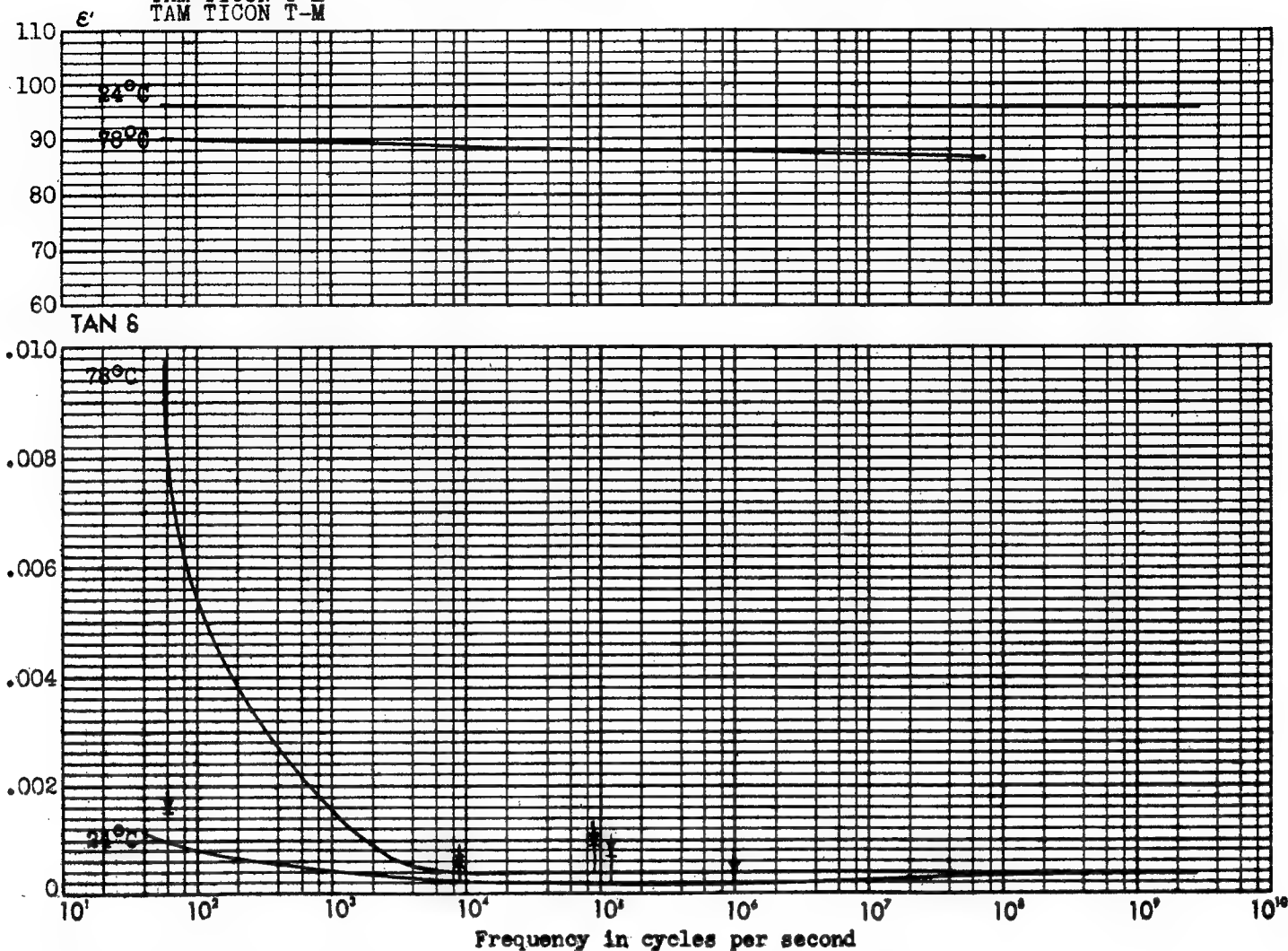
Recommended Uses: Temperature correction capacitors; mica substitute.

Availability: As powder in production quantities.

TAM TICON T-J  
TAM TICON T-L  
TAM TICON T-M

Fired 6 hrs. at 1350°C

TITANIUM ALLOY MFG. CO.



Composition: Rutile form  $\text{TiO}_2$ . Chief impurities  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ .

Firing Conditions: Oxidizing, 1260°C.

Properties: Tan to cream.  $d^{20}=4.24$ .  $T_{\text{soft}} 1540^\circ\text{C}$ . Therm. Sta.: refractory.  
Res. Therm. Shock: fair. Chem. Res.: acids, fuming  $\text{H}_2\text{SO}_4$  and HF, poor; alkalies, excellent; water, excellent; steam, excellent. Moist. Abs. <0.1%. Elec. Str. 100-150.  
Vol. Res.  $1.10^{13}$ - $1.10^{14}$ .  $n_D=2.6$  (a) and 2.9 (c). Light Trans.: opaque in fired body.

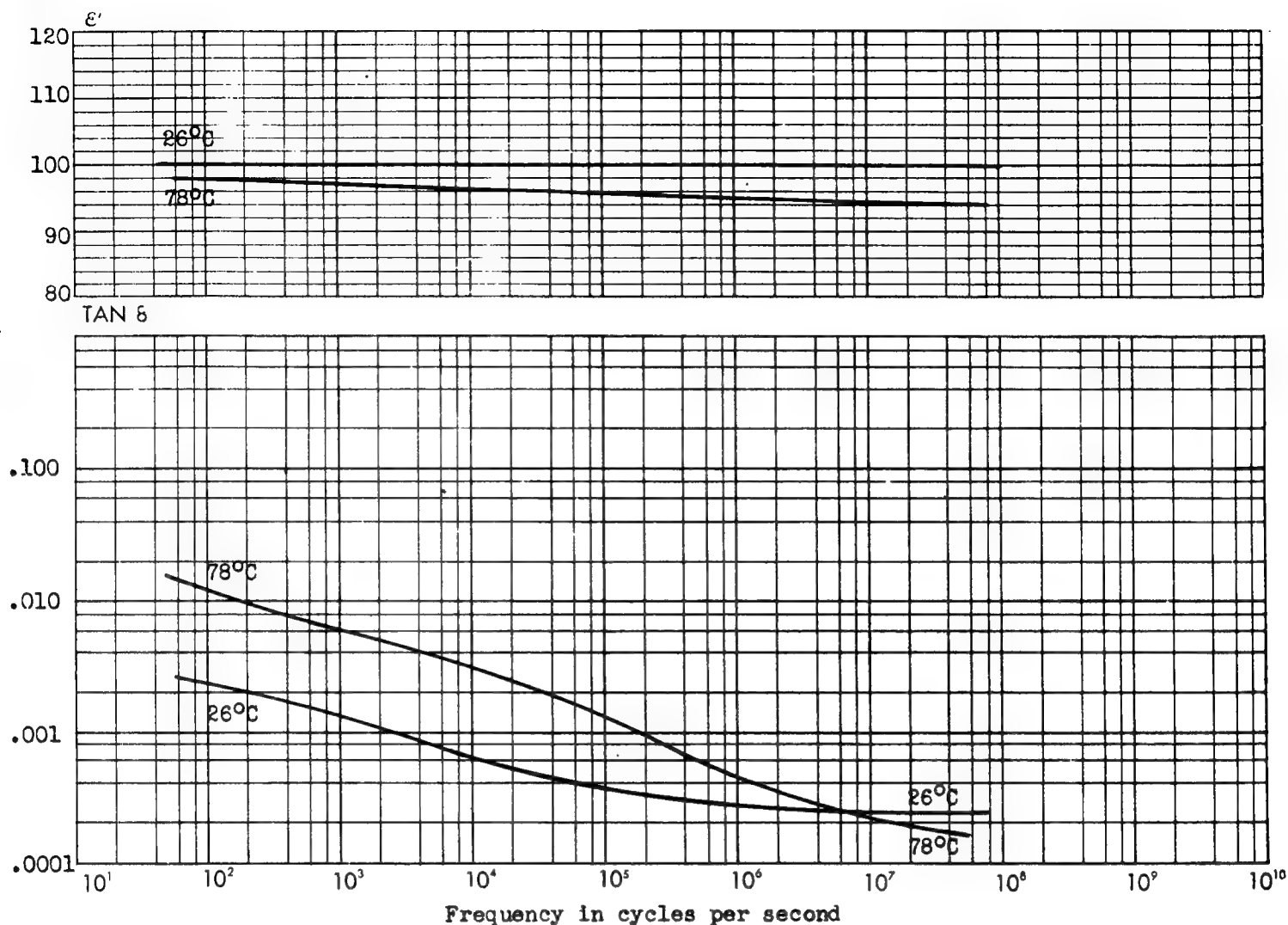
Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: Temperature correction capacitors; mica substitute.

Availability: As powder in production quantities on order.

TI-PURE R-200, Fired 8 hrs. at 1350°C.

E. I. DU PONT DE NEMOURS & CO., INC.



Composition: Titanium dioxide, rutile form.

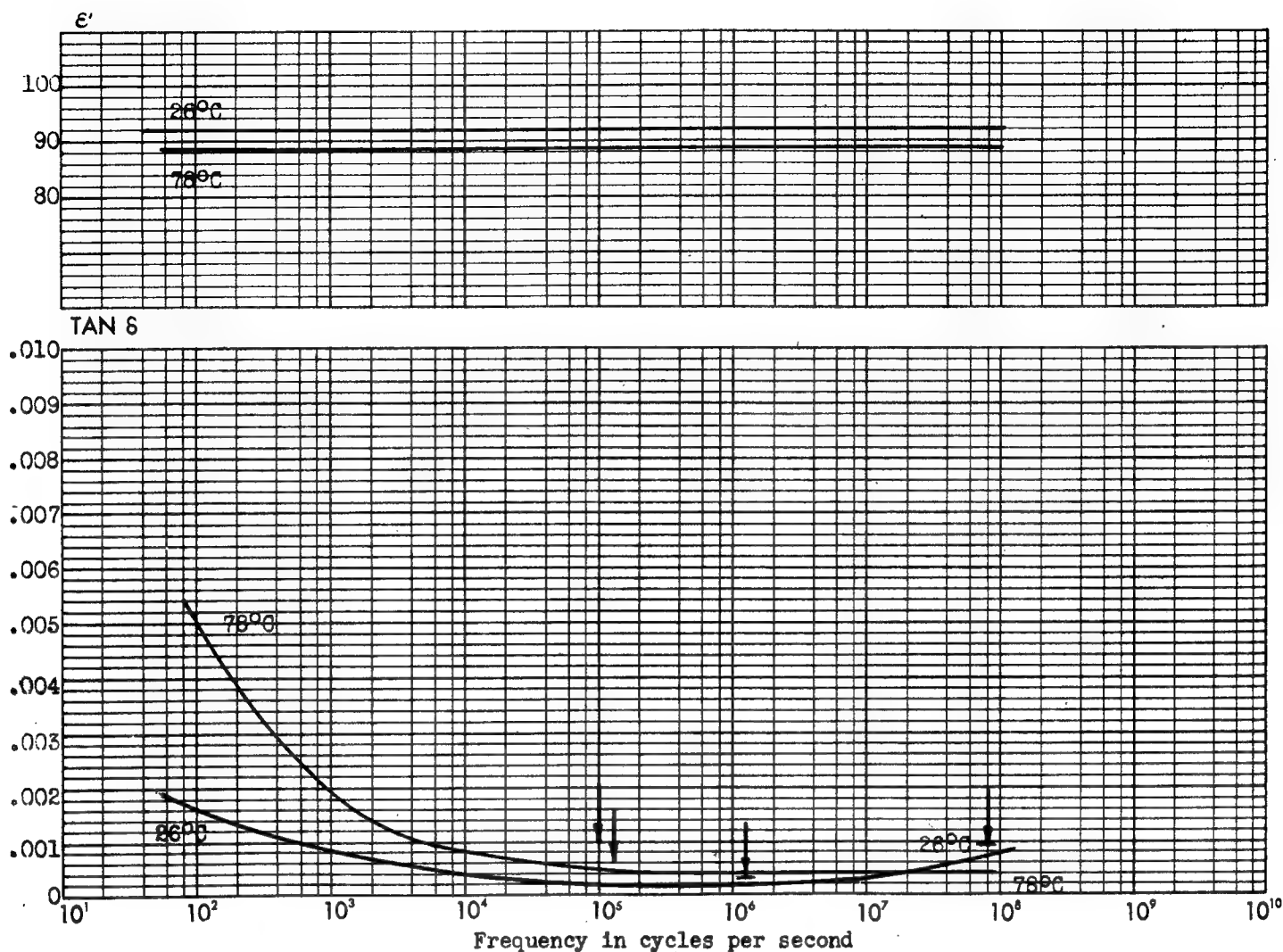
Firing Conditions: Oxidizing, schedule firing to 1350°C.

Properties: Cream, opaque.  $d_{25}^{25}=4.14$ . Therm. Sta.: refractory. Res. Therm. Shock: fair. Chem. Res.: acids, excellent except fuming  $H_2SO_4$  and HF; alkalies, excellent; water, excellent; steam, excellent.

Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: Temperature correction capacitors; mica substitute.

Availability: As powder in production quantities.



Composition: Rutile form  $\text{TiO}_2$  with 1.5% Corning glass #790.

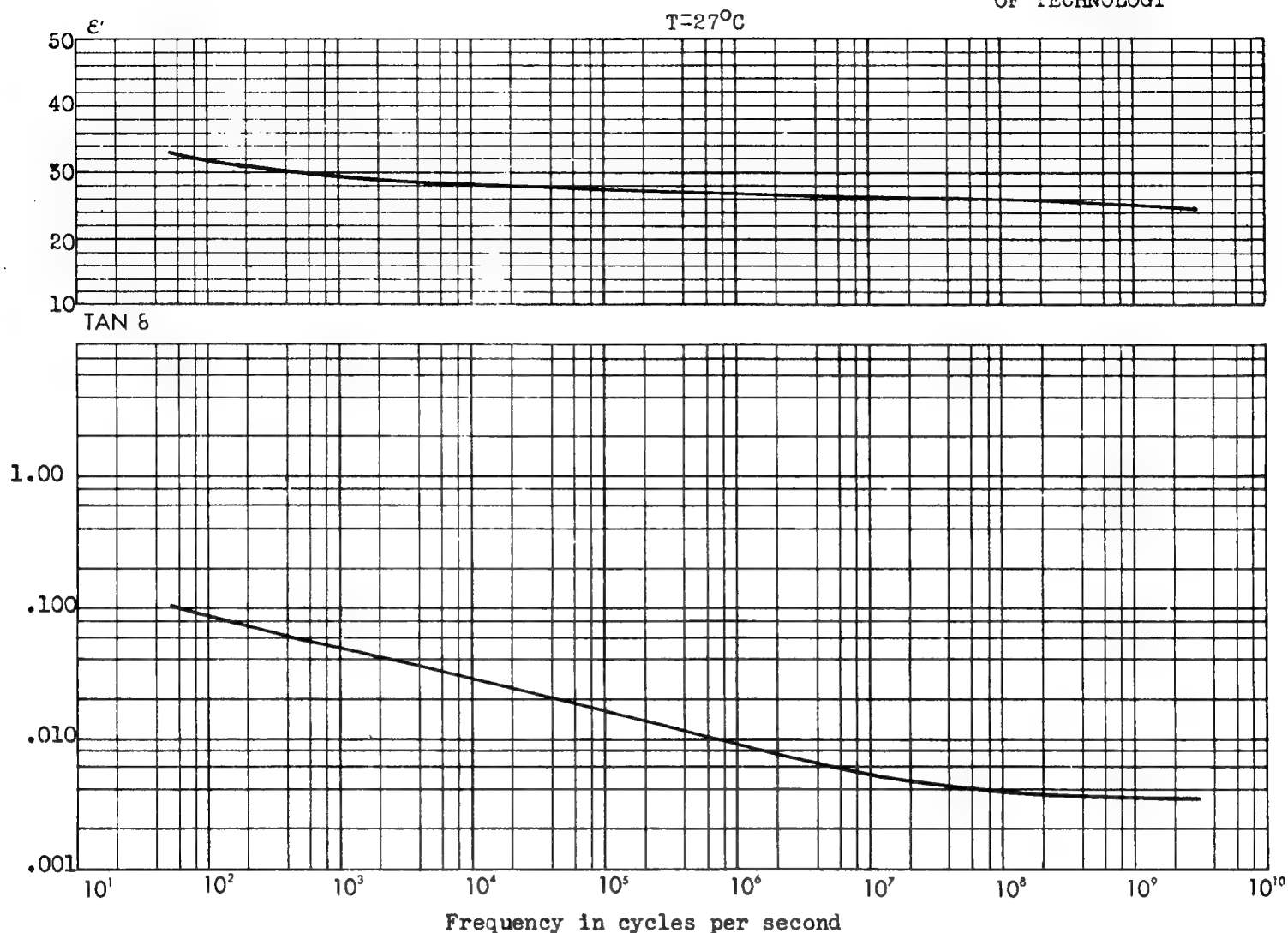
Firing Conditions: Oxidizing, schedule firing to 1350°C.

Properties: Cream, opaque.  $d^{25}=4.08$ . Therm. Sta.: refractory.

Res. Therm. Shock: fair. Chem. Res.: acids, good except fuming  $\text{H}_2\text{SO}_4$  and HF; alkalis, excellent; water, excellent; steam, excellent. Elec. Str. 300.

Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: Capacitors with improved electrical strength.



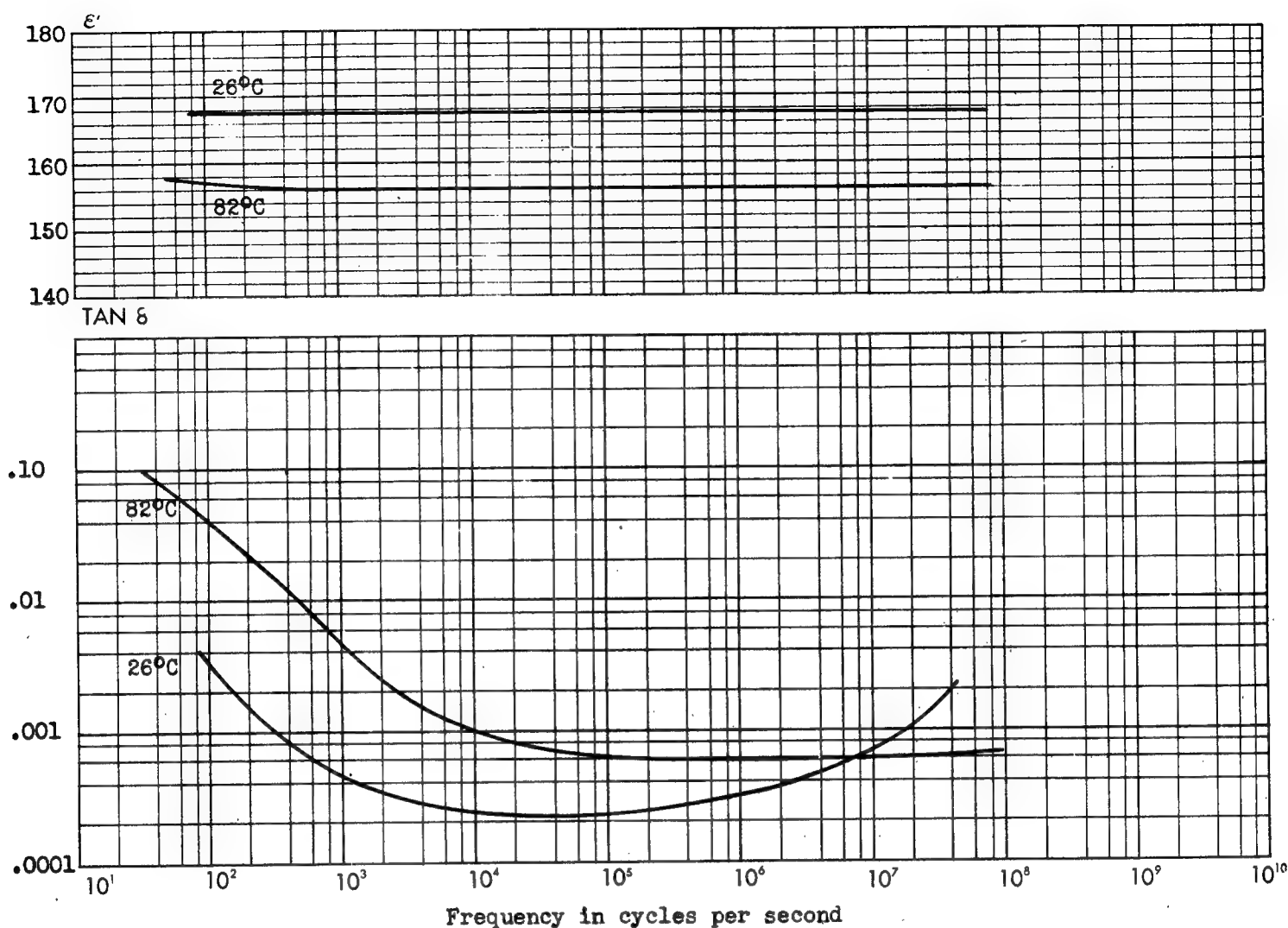
Chemical Name: Titanium dioxide and polystyrene

Composition: Titanium dioxide, Titanium Alloy Mfg. Co. TAM Ticon T-J (89%) and polystyrene, Bakelite XMS 4A-621 (11%).

Properties: Opaque, white.  $d^{25}_D=3.0$ . Mach.: poor.

Method of Handling: Compr. Mold. 10,000  $25^{\circ}\text{C}$ , 10 hrs. followed by 10,000,  $180^{\circ}\text{C}$  max., 2 hrs.





Composition:  $\text{CaTiO}_3$ . Chief impurities  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{MgO}$ .

Firing Conditions: Oxidizing, schedule firing to  $1400^\circ\text{C}$ .

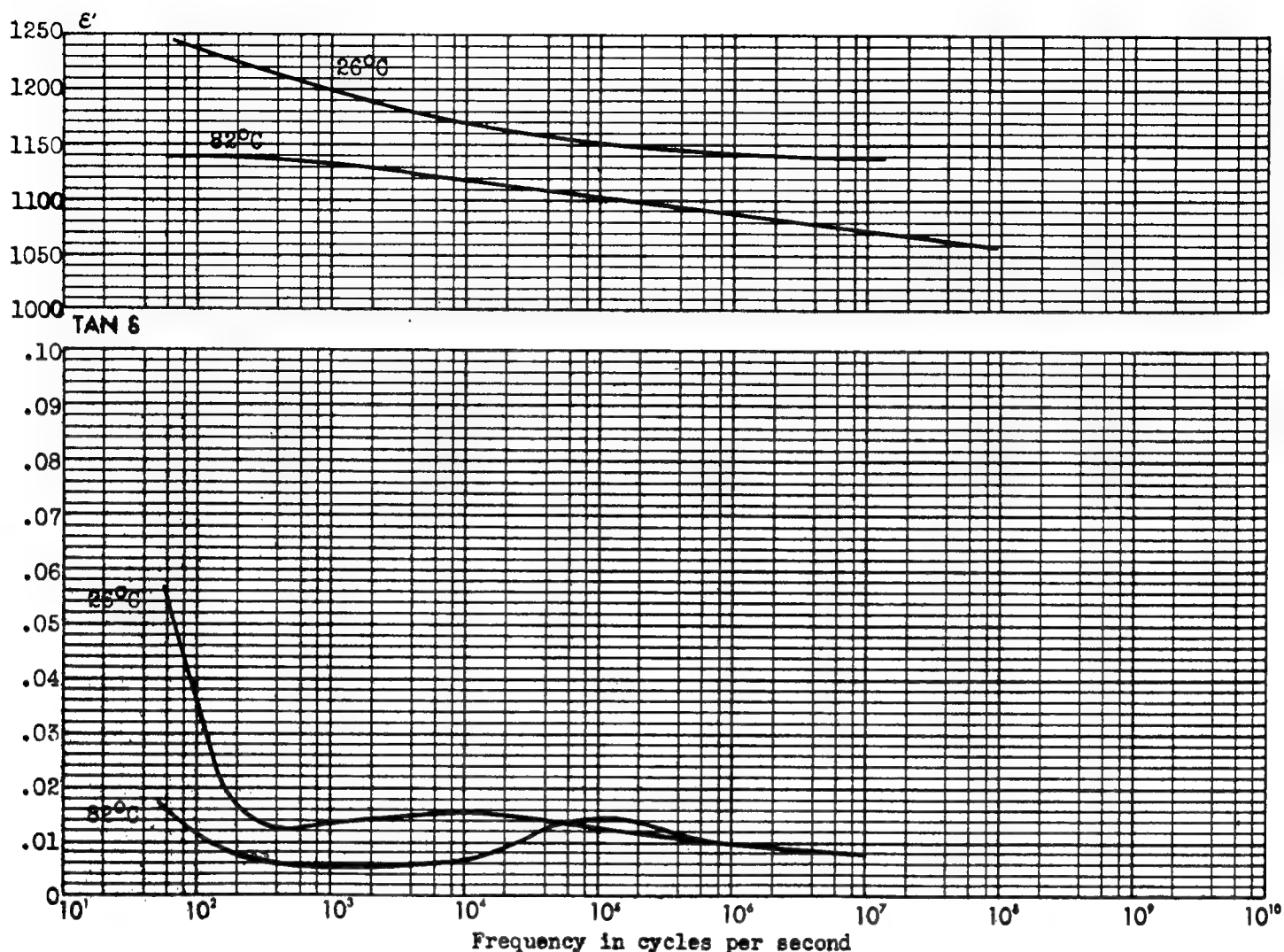
Properties: Cream colored powder; fired body, salmon.  $d^{20} = \text{ca. } 4.5$ .  $T_{\text{soft}} 1510^\circ\text{C}$ . Therm. Sta.: refractory. Res. Therm. Shock: fair. Chem. Res.: strong acids, poor; alkalis, good; water, excellent; steam, excellent. Moist. Abs.  $< 0.1\%$ . Elec. Str. 100-125. Vol. Res.  $1.10^{12}$ - $1.10^{14}$ .  $n_D = \text{ca. } 2.2$ . Light Trans.: opaque in fired body.

Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: Temperature correction capacitors, mica substitute or in capacitor usage where low power factor is required.

Availability: As powder in production quantities on order.





Composition:  $\text{BaTiO}_3$ . Chief impurities  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Na}_2\text{O}$ ,  $\text{SrO}$ .

Firing Conditions: Oxidizing; schedule firing 150°C per hr. to 1350°C.

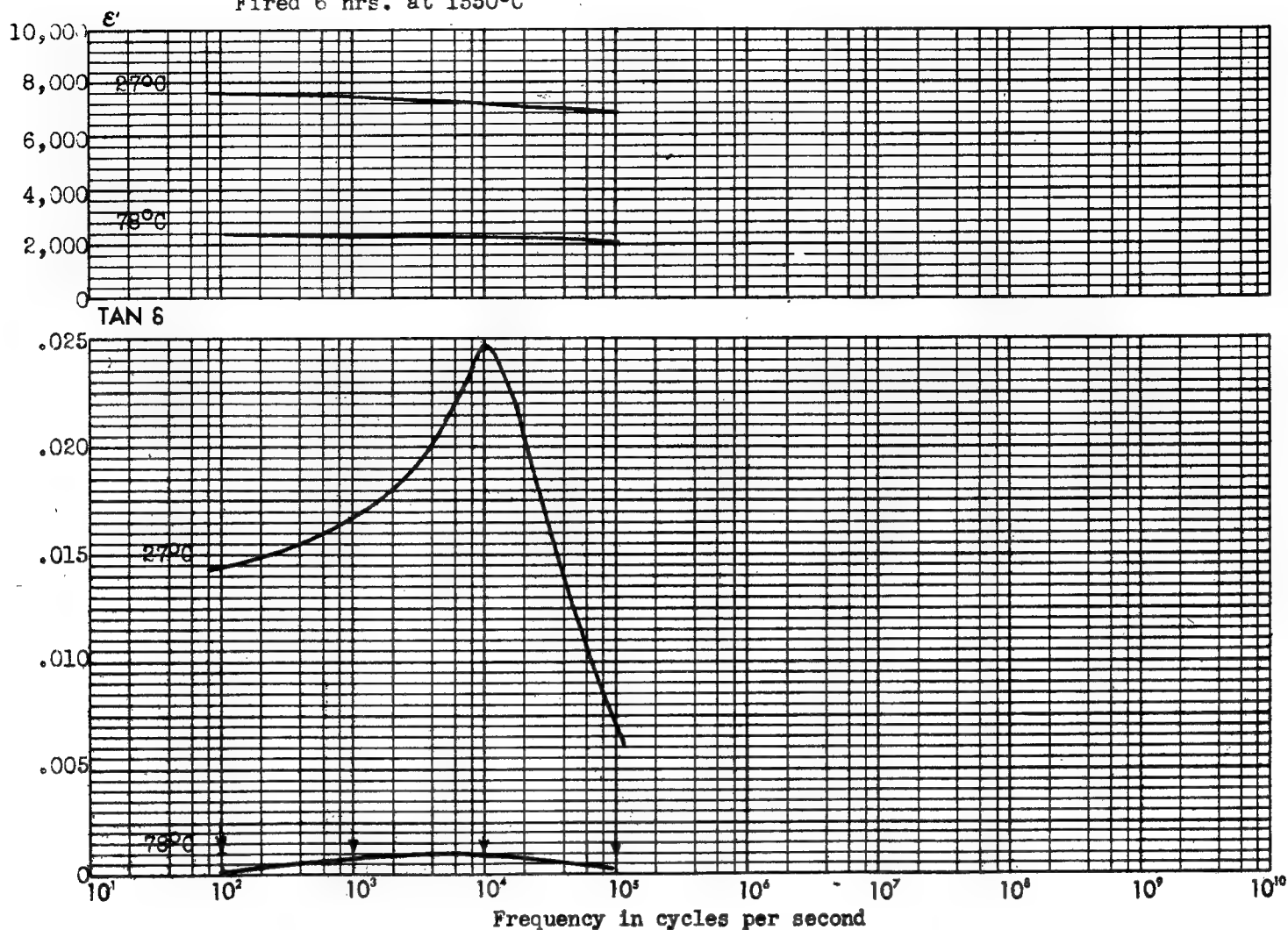
Properties: Cream colored powder, fired body buff.  $d^{20} = \text{ca. } 5.5$ .  $T_{\text{soft}} 1400\text{--}1430^\circ\text{C}$ . Therm. Sta.: refractory. Res. Therm. Shock: poor. Chem. Res.: strong acids, poor; alkalis, fair; water, good; steam, fair. Moist. Abs. 0.1%. Elec. Str.: ca. 75. Vol. Res.  $1.10^{12}\text{--}1.10^{13}$ .  $n_D = \text{ca. } 2.4$ . Light Trans.: opaque in fired body.

Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: By-pass and filter condensers. High capacity in small space where power factor is not important.

Availability: As powder in production quantities on order.

NOTE: Dielectric data depends on field strength which was not accurately controlled.



Composition: BaSrTiO<sub>3</sub>. Chief impurities SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Na<sub>2</sub>O.

Firing Conditions: Oxidizing, 1330°C.

Properties: Pink cream, fired body buff. d<sub>20</sub> = ca. 5.0. T<sub>soft</sub> 1430°C.

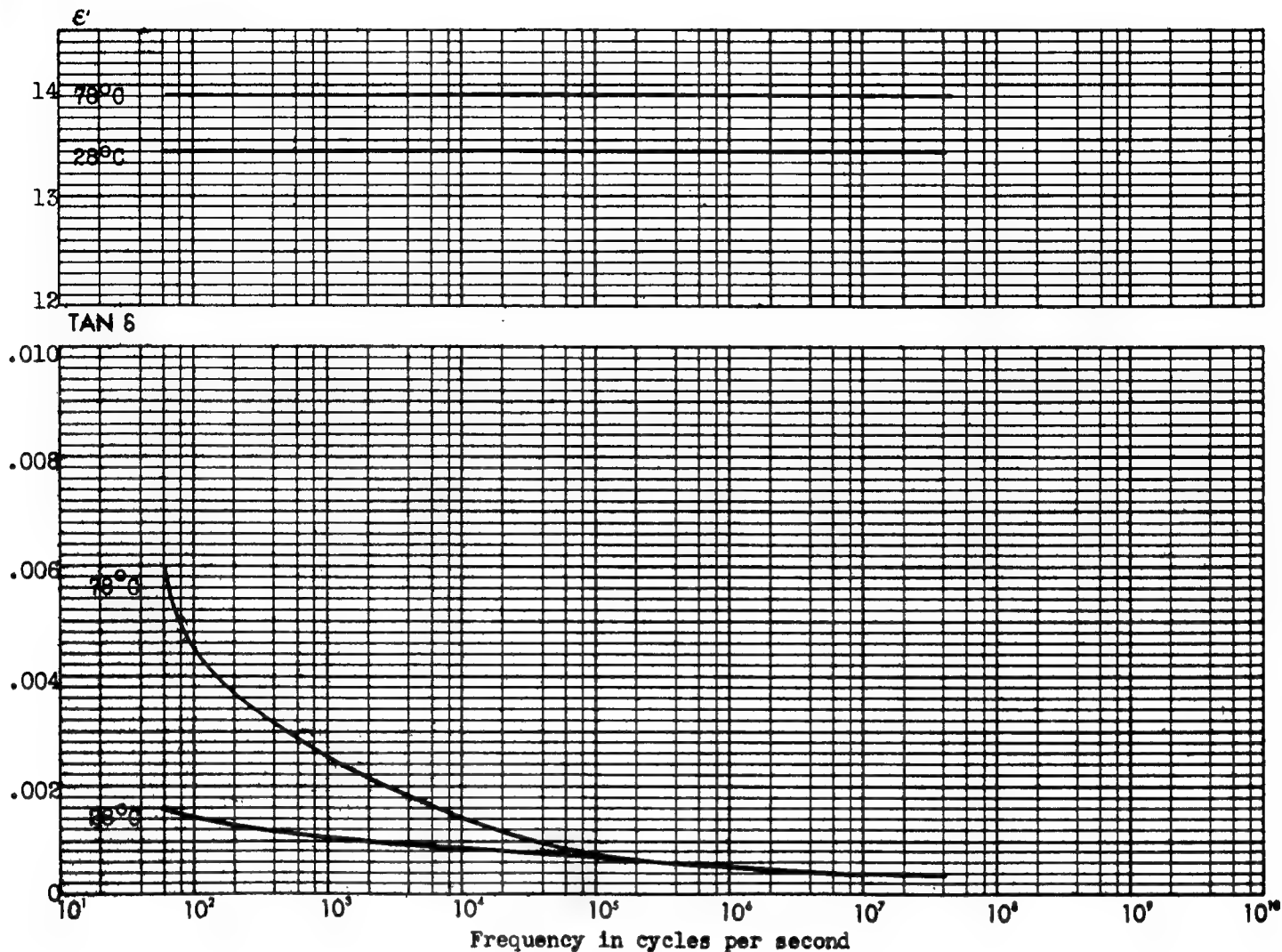
Therm. Sta.: refractory. Res. Therm. Shock: poor. Chem. Res.: strong acids, poor; alkalis, good; water, excellent; steam, excellent. Moist. Abs. < 0.1%. Elec. Str. 75. Vol. Res. 1.10<sup>12</sup>-1.10<sup>13</sup>. n<sub>D</sub> = ca. 2.2. Light Trans.: opaque in fired body.

Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: As a room temperature by-pass and filter capacitor. As a filler for condenser paper and resins.

Availability: Available as powder in production quantities on order.

NOTE: Dielectric data depends on field strength which was not accurately controlled.



Composition:  $\text{MgTiO}_3$  containing  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$ .

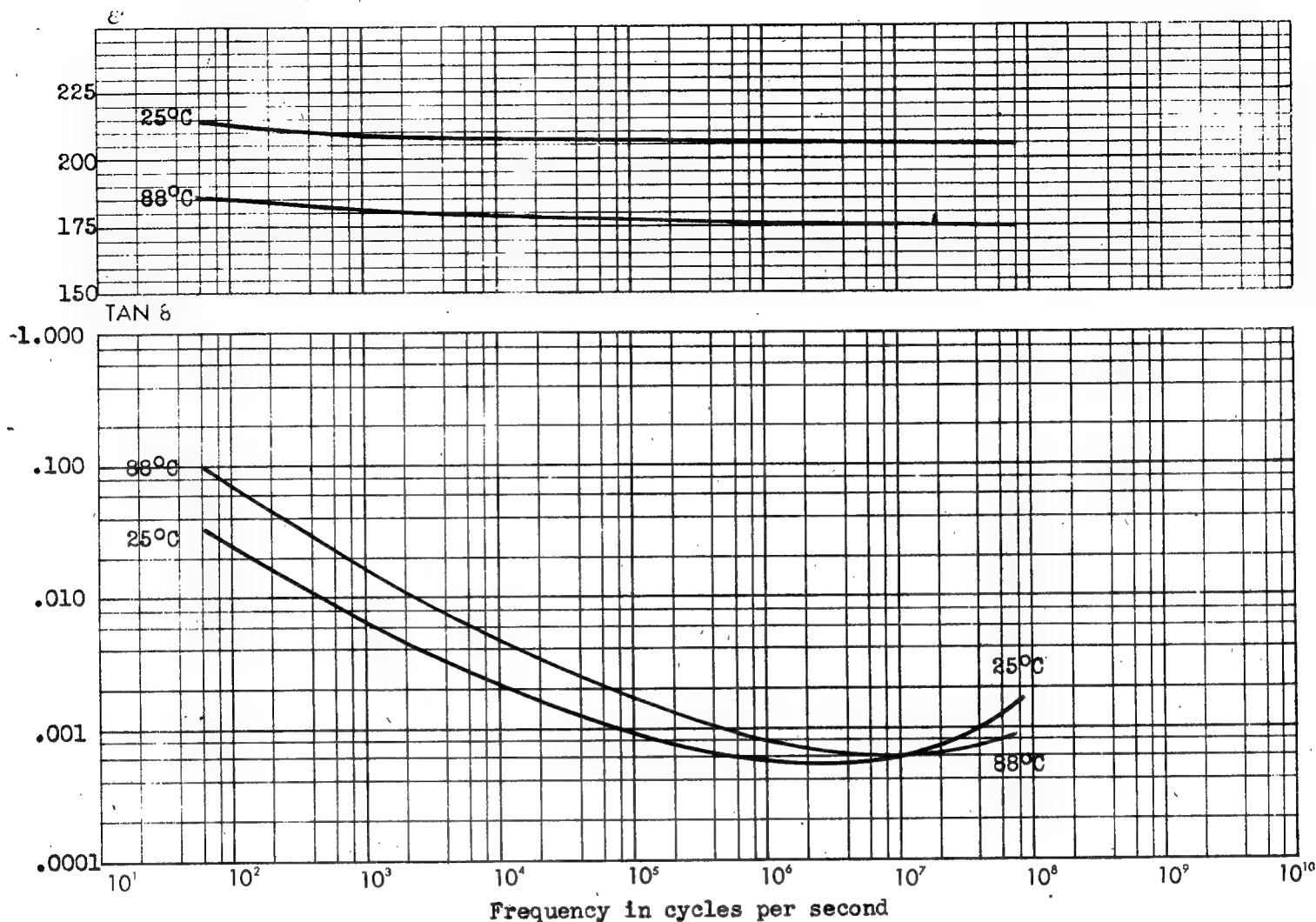
Firing Conditions: Oxidizing, 1260°C

Properties: White.  $T_{\text{soft}}$  1430°C. Therm. Sta.: refractory. Res. Therm. Shock: good. Chem. Res.: strong acids, poor; alkalis, fair; water, excellent; steam, excellent. Moist. Abs.  $\leq 0.1\%$ . Elec. Str. 100. Vol. Res.  $1 \cdot 10^{13}$ – $1 \cdot 10^{14}$ .  $n_D = \text{ca. } 2.21$ .

Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: For preparation of positive and neutral temperature coefficient capacitors.

Availability: As a powder in production quantities on order.



Composition:  $\text{SrTiO}_3$ . Chief impurities  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Na}_2\text{O}$ ,  $\text{BaO}$ .

Firing Conditions: Oxidizing, on schedule to 1370-1400°C.

Properties: Pink buff powder; fired body buff.  $d^{20} = \text{ca. } 5.0$ .  $T_{\text{soft}} 1510^\circ\text{C}$ .

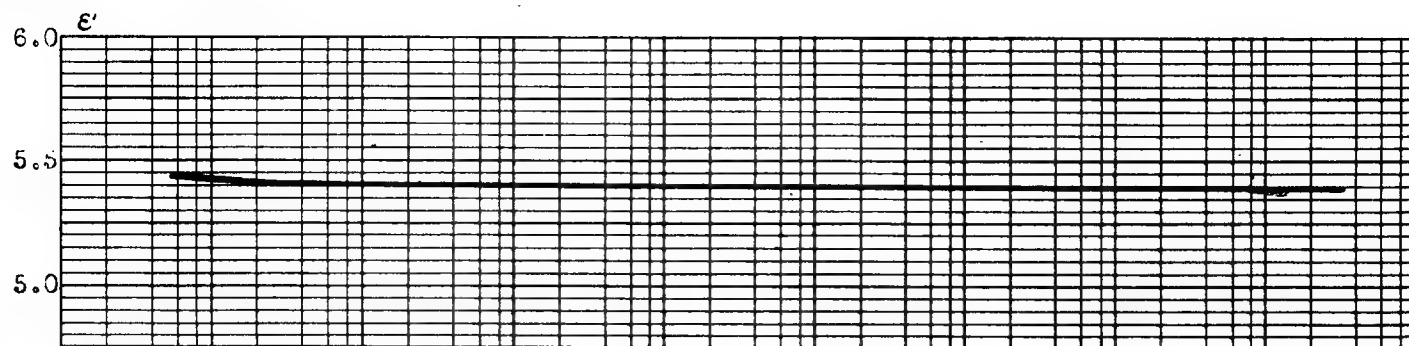
Therm. Sta.: refractory. Res. Therm. Shock: fair. Chem. Res.: strong acids, poor; alkalis, good; water, excellent; steam, excellent. Moist. Abs. 0.1%.

Elec. Str. 100-125. Vol. Res.  $1 \cdot 10^{12}$  -  $1 \cdot 10^{14}$ .  $n_D = \text{ca. } 2.3$ . Light Trans.: opaque in fired body.

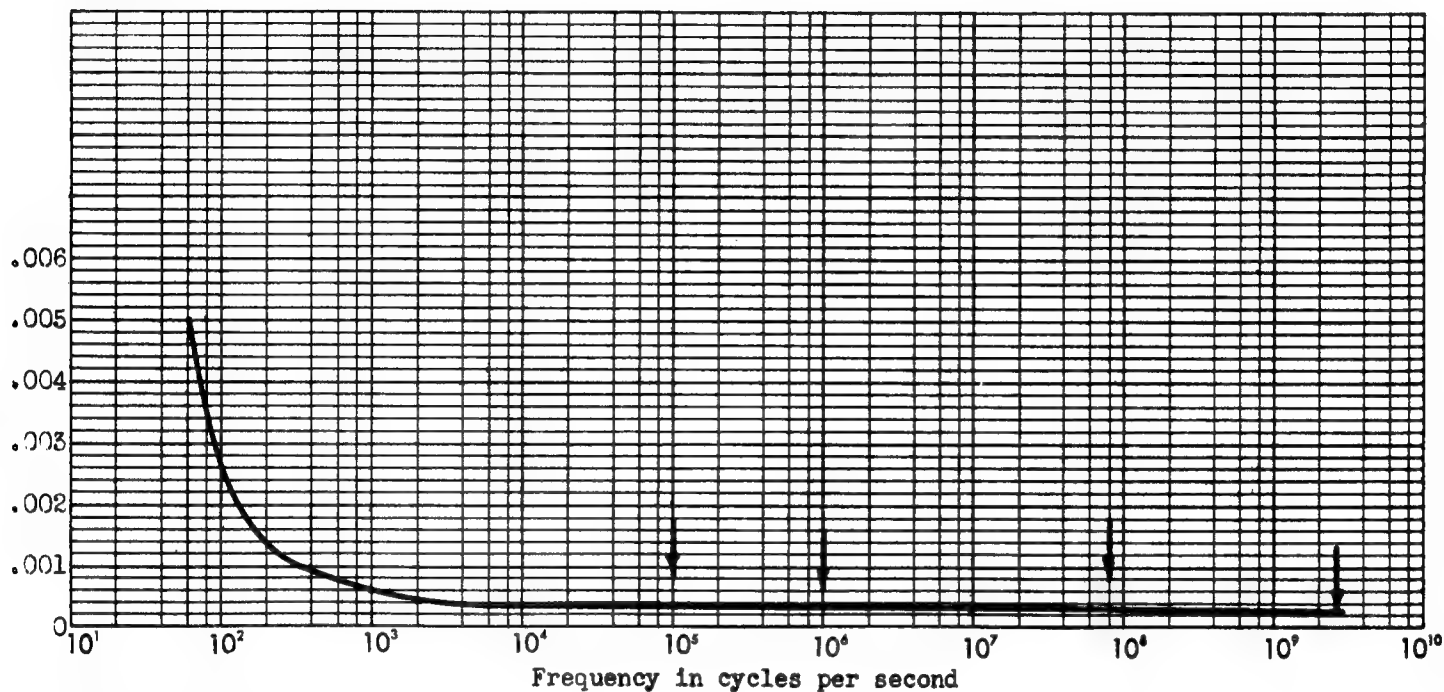
Methods of Handling: Dry pressing, extrusion and slip casting possible.

Recommended Uses: Temperature correction capacitors, mica substitute or in capacitor usage where low power factor is required.

Availability: Powder in production quantities on order.



TAN δ



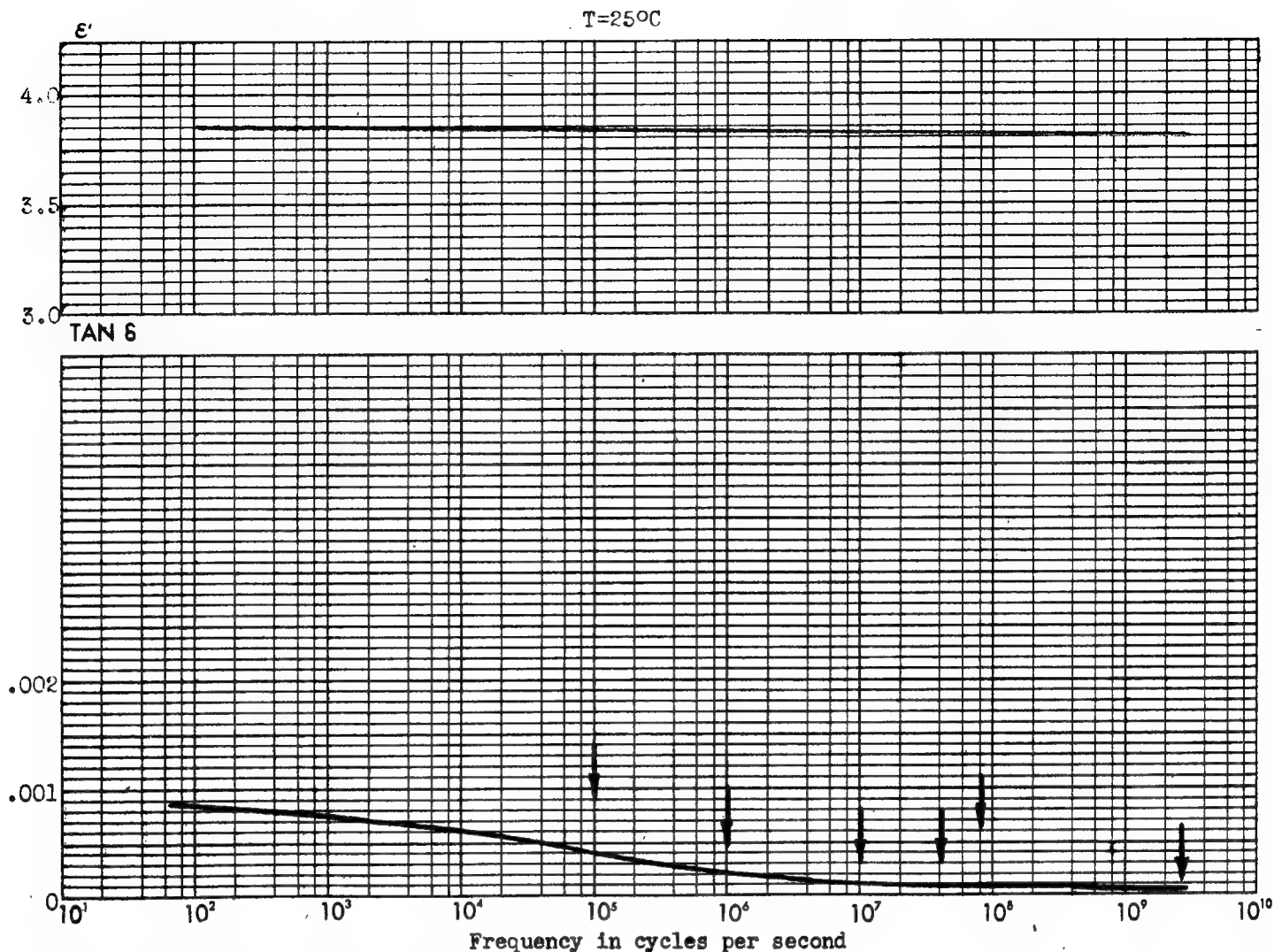
Chemical Name: Muscovite

Composition:  $K_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2H_2O$ .

Properties: From "Handbook of Chemistry and Physics" 26th Ed. Chemical Rubber Publishing Co. Light grey to brown, transparent.  $d^{25} = 2.76-3.00$ , Mohs' scale 2.8. Spec. Heat 0.2061. Therm. Cond.  $1.8 \times 10^{-8}$ . Surf. Res.:  $1 \times 10^{10}$  50% humidity;  $9 \times 10^7$  90% humidity. Vol. Res.  $5 \times 10^{13}$ . Elec. Str. 590-870 (.1mm.); 118-276 (1mm.).  $n_D = 1.590$ .

Recommended Uses: Electrical insulation, heat insulation, furnace windows, etc.

Availability: Under allocation.



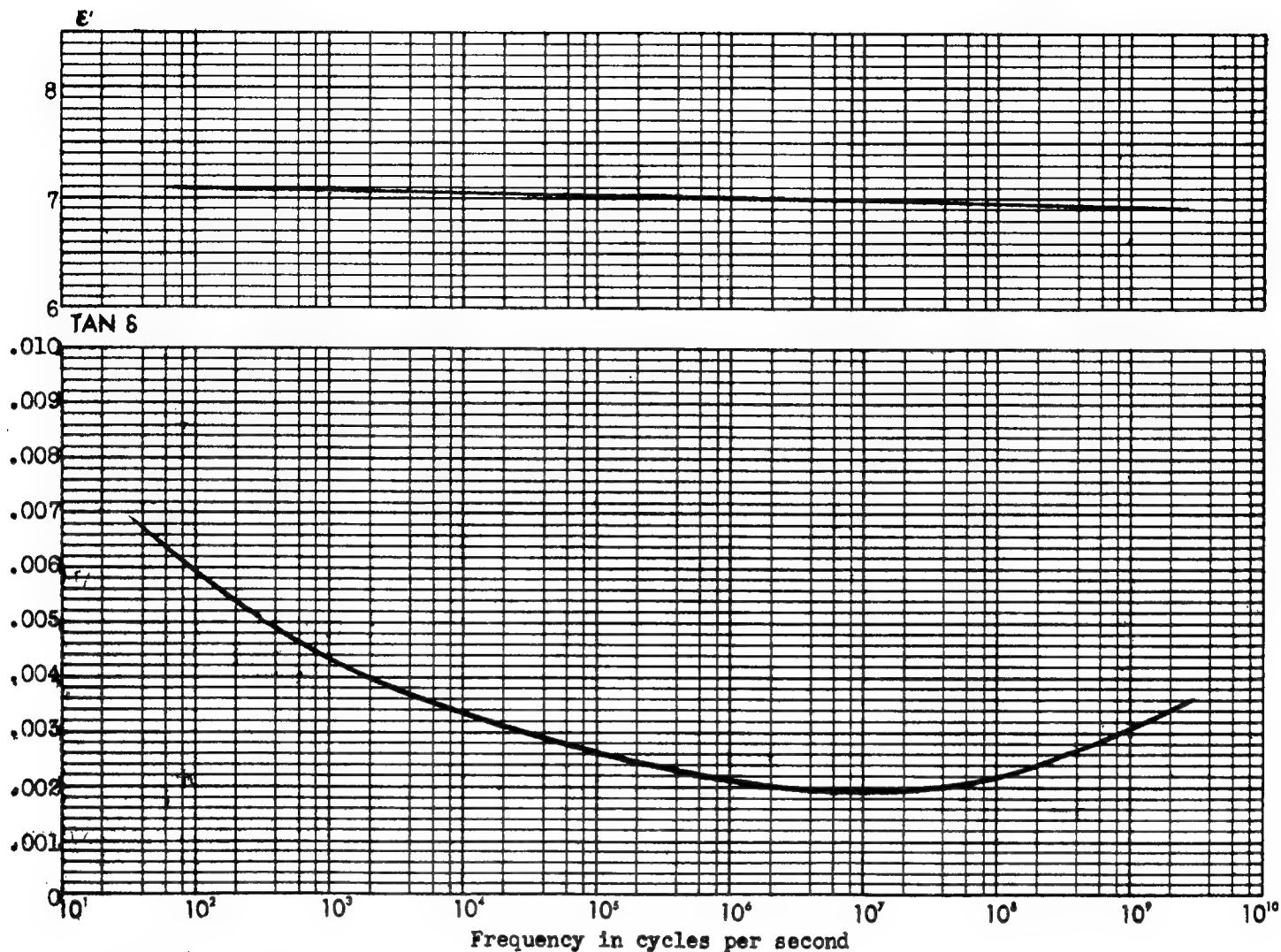
Chemical Name: Silicon dioxide.

Composition: Practically pure silica

Properties: Colorless, clear.  $d^{25}=2.20$ . Comp. Str. 190,000. Ten. Str. 7000. Mod. El.  $9.4 \times 10^6$ . Mohs' scale 4.9. M. P. 1750°C.  $T_{\text{soft}} 1667^\circ\text{C}$ .  $T_{\text{ann}} 1140^\circ\text{C}$ . Strain Point 1070°C. Therm. Cond.  $3.3 \times 10^{-3}$ . Spec. Heat 0.18. Chem. Res.: acids, good for all except HF and hot phosphoric; alkalies, fair at room temp. Elec. Str.: 15,000 25°C; 5000 100°C. Vol. Res.  $>1 \times 10^{19}$  25°C,  $3 \times 10^{10}$  350°C. Surf. Res.:  $2-10 \times 10^{10}$  50% humidity;  $2-5 \times 10^6$  90% humidity.  $n_D=1.458$ .

Recommended Uses: High quality insulator.

Availability: Manufactured primarily in ingots, rods and tubing. Normally supplied rough cut for finishing to specifications of the purchaser.



Composition: Ground mica and soft glass.

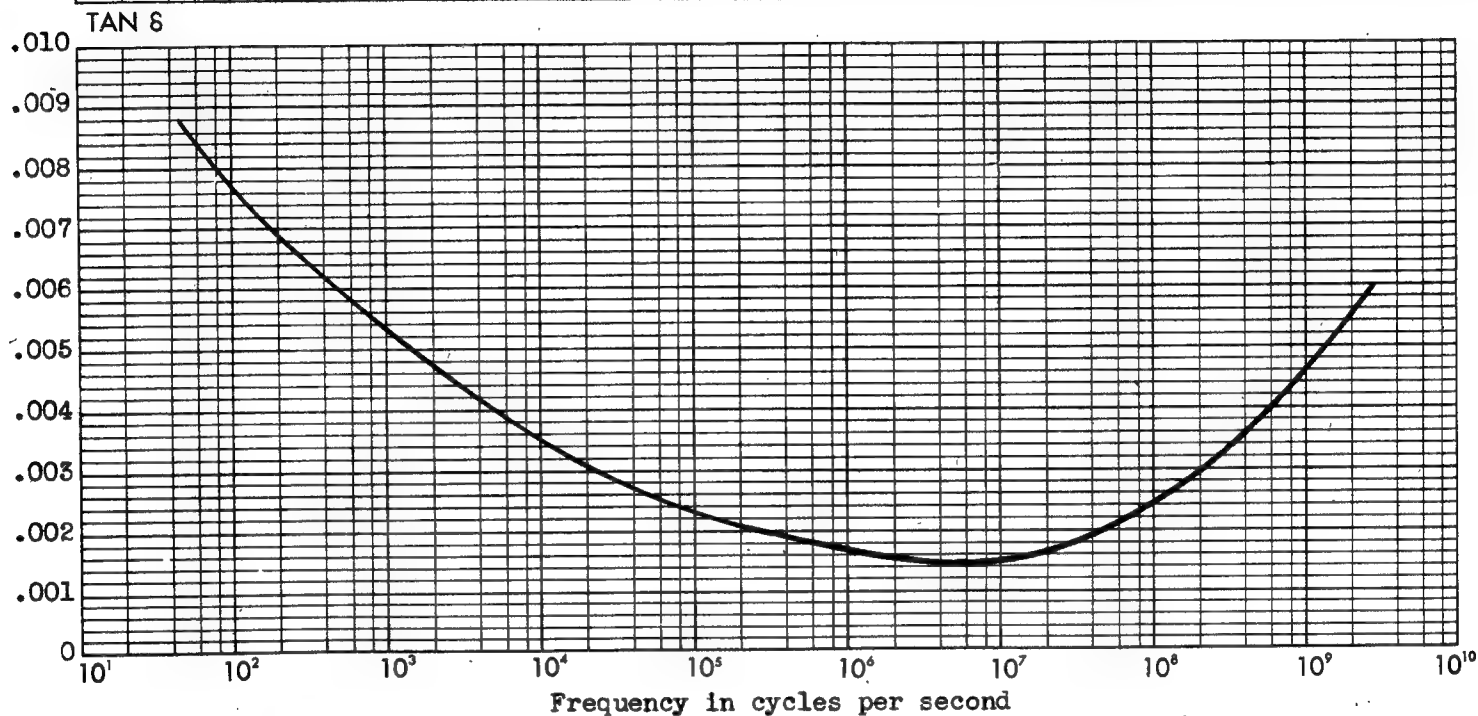
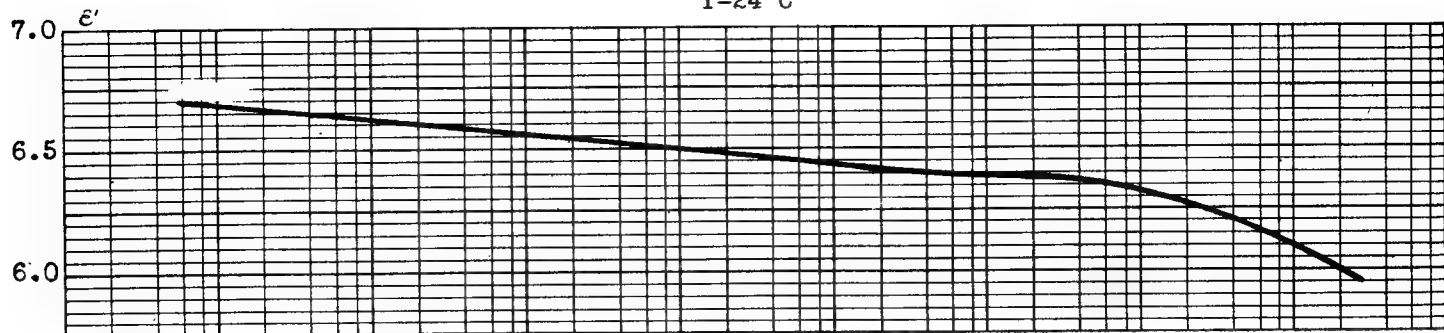
Properties: Gray, smooth surface.  $d^{25}=2.95$ . Ten. Str. 5000-7000. Rockwell L125. Brinell 40-50. Imp. 0.90 (3/4" diam. rod). Comp. Str. 30,000(min.) Mach.: poor Spec. Heat 0.2. Therm. Exp.  $8 \times 10^{-6}$ . Therm. Cond.  $13.7 \times 10^{-4}$ . Therm. Sta.: good to 325°C. Moist. Abs. 0.003%. Elec. Str. 360 (0.2 inch thick). Arc Res. 260.

Recommended Uses: High temperature electrical insulator.

Availability: Commercial quantities of plates, rods, strips and discs (to be machined to finished shapes); compression molded into simple shapes.



T=24°C



Composition: Soda-potash-lead silicate. PbO (ca. 20%).

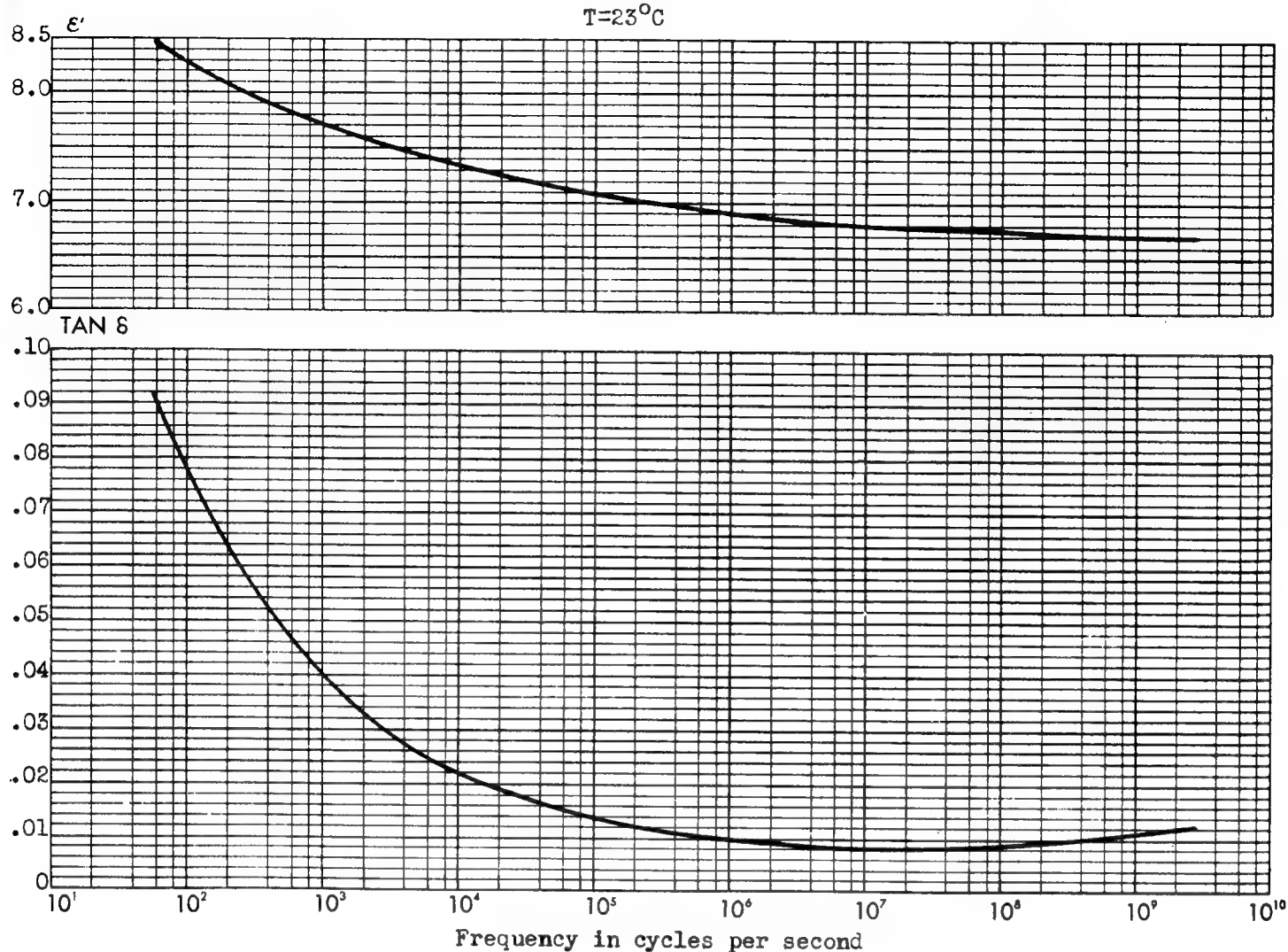
Properties: Light green, clear.  $d^{25}=2.85$ . Therm. Exp.  $90 \times 10^{-7}$ .  
 Tann 425°C. Tsoft 626°C. Therm. Sta. 389°C. Vol. Res.:  $1.33 \times 10^7$  at 350°C;  
 $1.19 \times 10^9$  at 250°C.  $n_D=1.542$ .

Methods of Handling: Seals to Platinum, Dumet, Sylvania #4, Driver Harris #14 and Corning glasses #008, #010 and #012.

Recommended Uses: General use where glass with high expansion and high resistance is desired.

Availability: Commercial production.





Composition: Soda-lime-silicate.

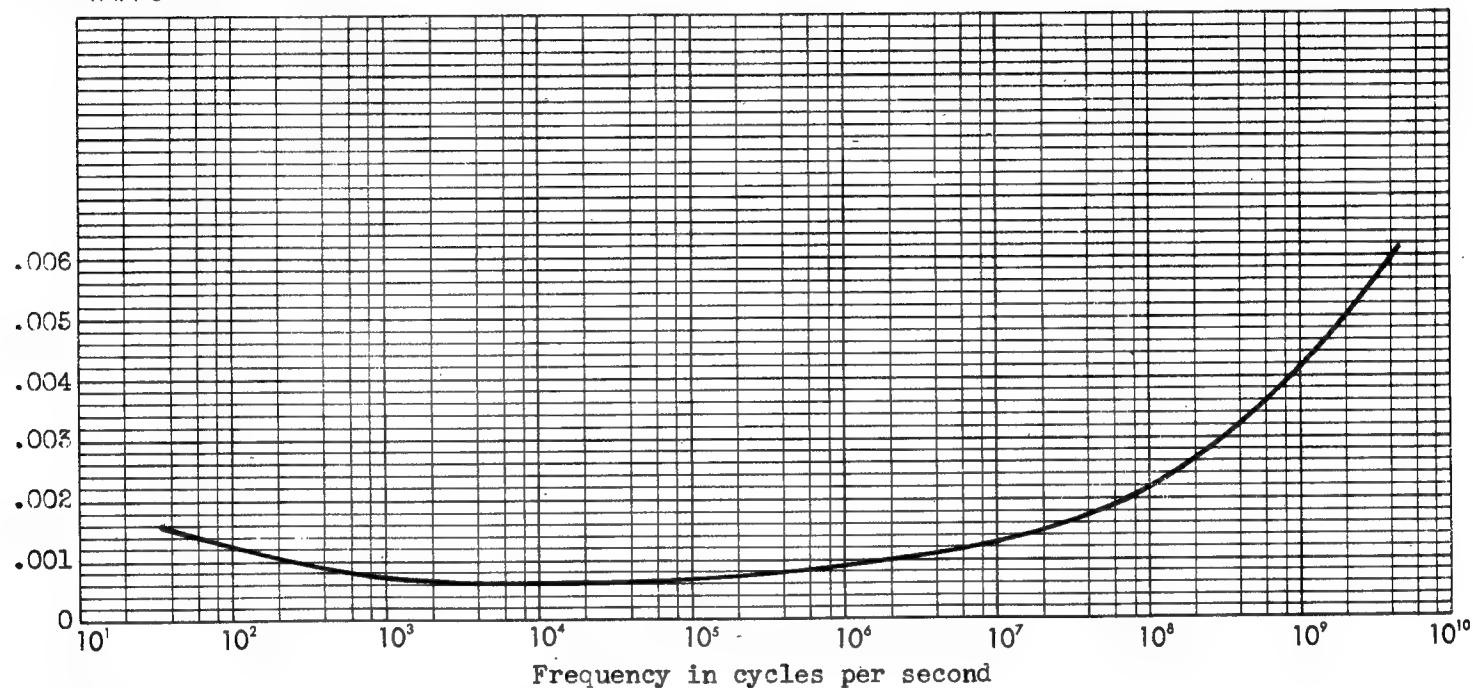
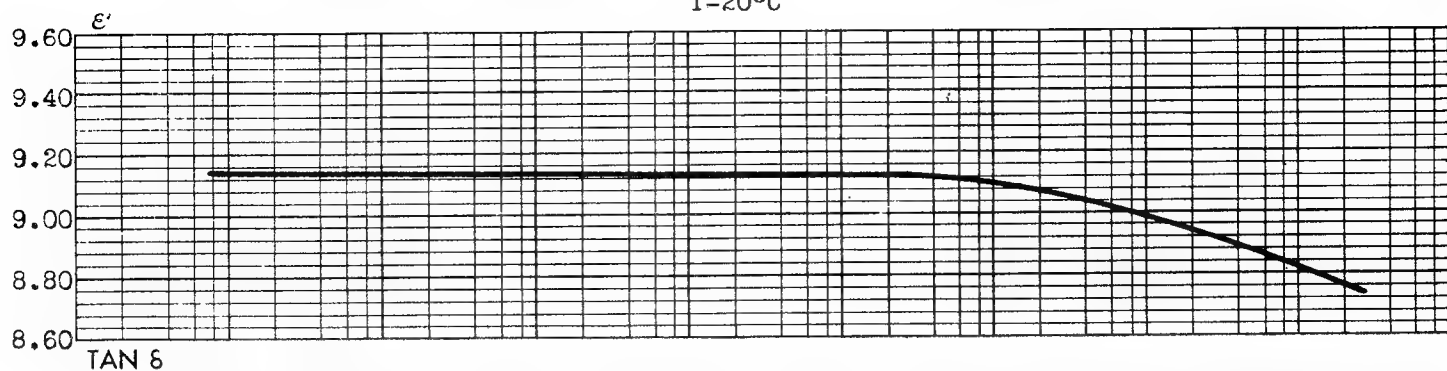
Properties: Colorless, clear.  $d^{25}=2.47$ . Therm. Exp.  $92 \times 10^{-7}$ .  
 Tann  $510^{\circ}\text{C}$ . Tsoft  $696^{\circ}\text{C}$ . Therm. Sta.  $475^{\circ}\text{C}$ . Vol. Res.:  $1.48 \times 10^5$  at  $350^{\circ}\text{C}$ ;  
 $5.13 \times 10^5$  at  $300^{\circ}\text{C}$ ;  $2.26 \times 10^6$  at  $250^{\circ}\text{C}$ .  $n_D=1.512$ .

Methods of Handling: Seals to Platinum, Dumet, Sylvania #4 and Corning glasses #001, #010 and #012.

Recommended Uses: Bulbs, bottles, windows.

Availability: Commercial production.

T=20°C



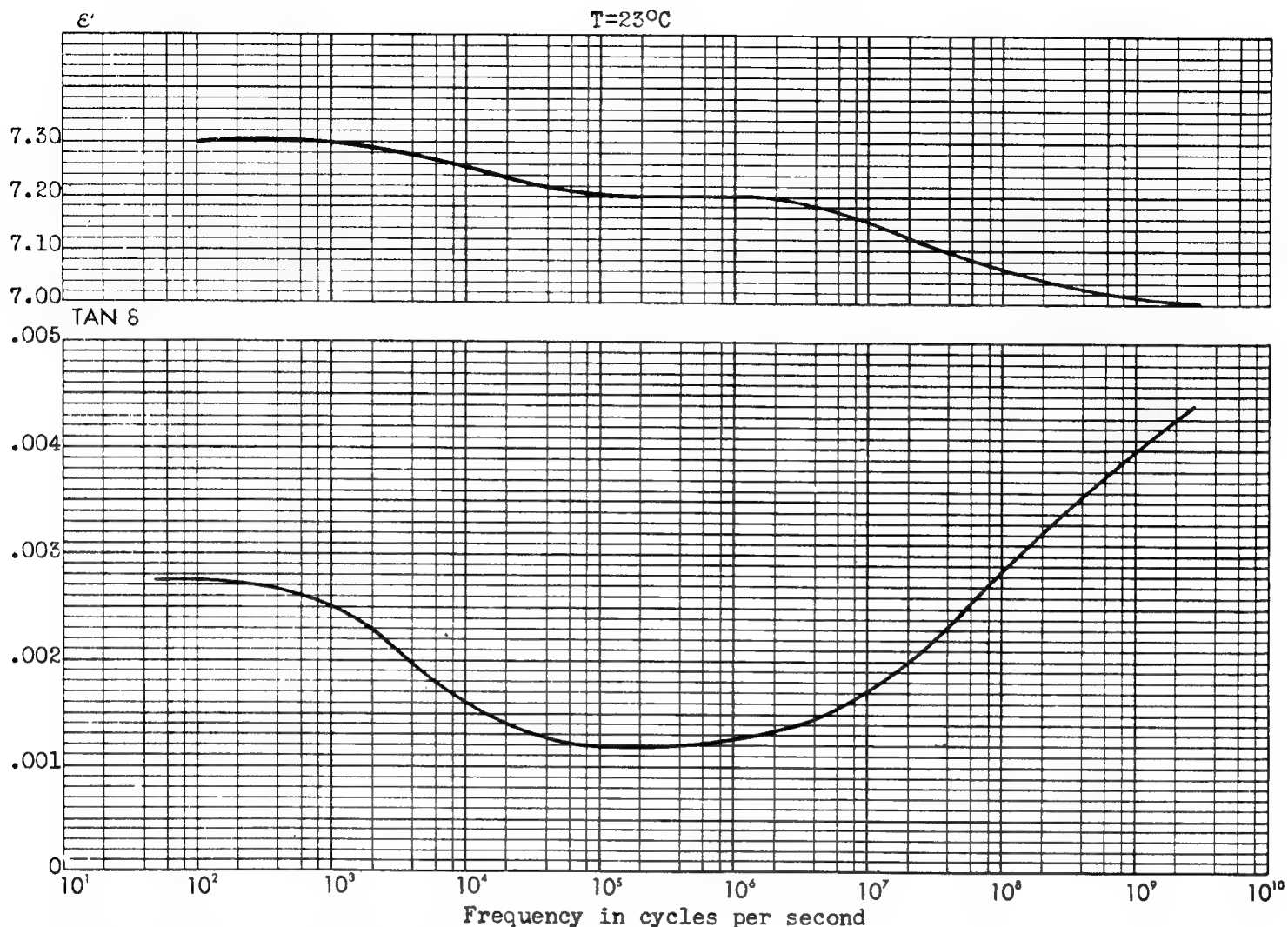
Composition: Potash-lead-silicate.

Properties: Yellowish tinge, clear.  $d^{25}=4.13$ . Therm. Exp.  $69 \times 10^{-7}$ .  
 Tann  $463^\circ\text{C}$ , Tsoft  $634^\circ\text{C}$ . Therm. Sta.  $428^\circ\text{C}$ . Vol. Res.:  $1.2 \times 10^{10}$  at  $350^\circ\text{C}$ ;  
 $2.24 \times 10^{12}$  at  $250^\circ\text{C}$ .  $n_D=1.67$ .

Methods of Handling: Seals to Platinum, Dumet and Corning glass #001.

Recommended Uses: Used for X-Ray shields.

Availability: Commercial production.



Composition: Potash-soda-barium-silicate.

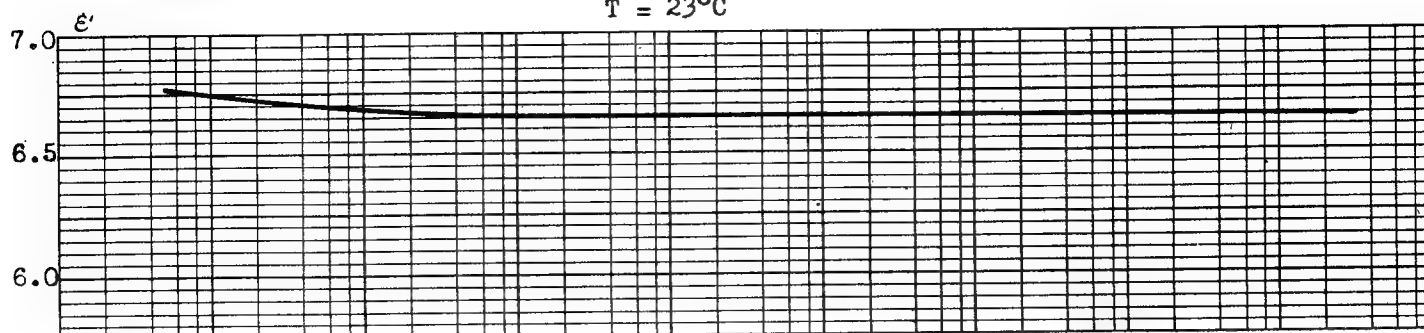
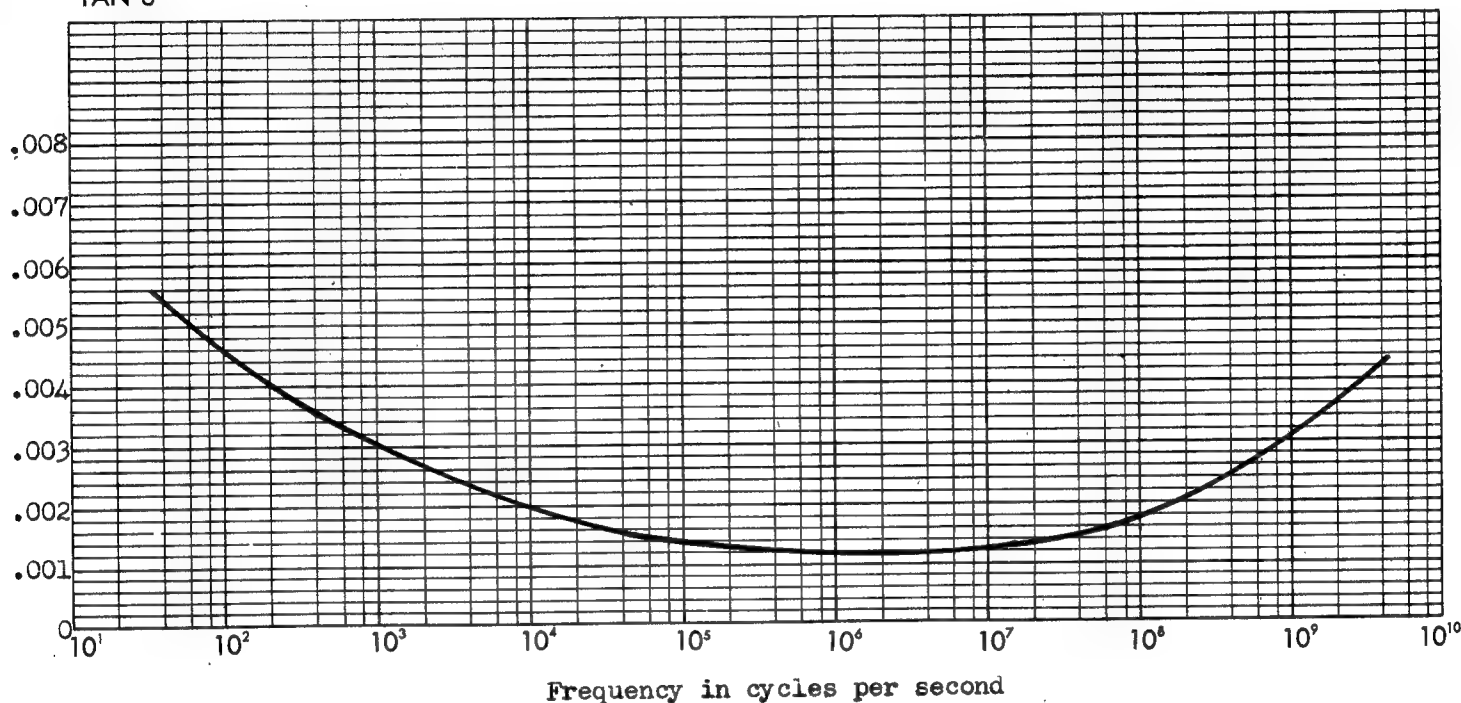
Properties: Colorless, clear.  $d^{25}=2.82$ . Therm. Exp.  $92 \times 10^{-7}$ .

$T_{\text{ann}} 527^\circ\text{C}$ .  $T_{\text{soft}} 692^\circ\text{C}$ . Therm. Sta.  $498^\circ\text{C}$ . Vol. Res.:  $3.98 \times 10^8$  at  $350^\circ\text{C}$ ;  $5.62 \times 10^{10}$  at  $250^\circ\text{C}$ .  $n_D-1.54$ .

Methods of Handling: Seals to Platinum, Dumet and Corning glass #001.

Recommended Uses: Where high expansion and high resistance is required - contains no lead.

Availability: Commercial production.

$T = 23^{\circ}\text{C}$ TAN  $\delta$ 

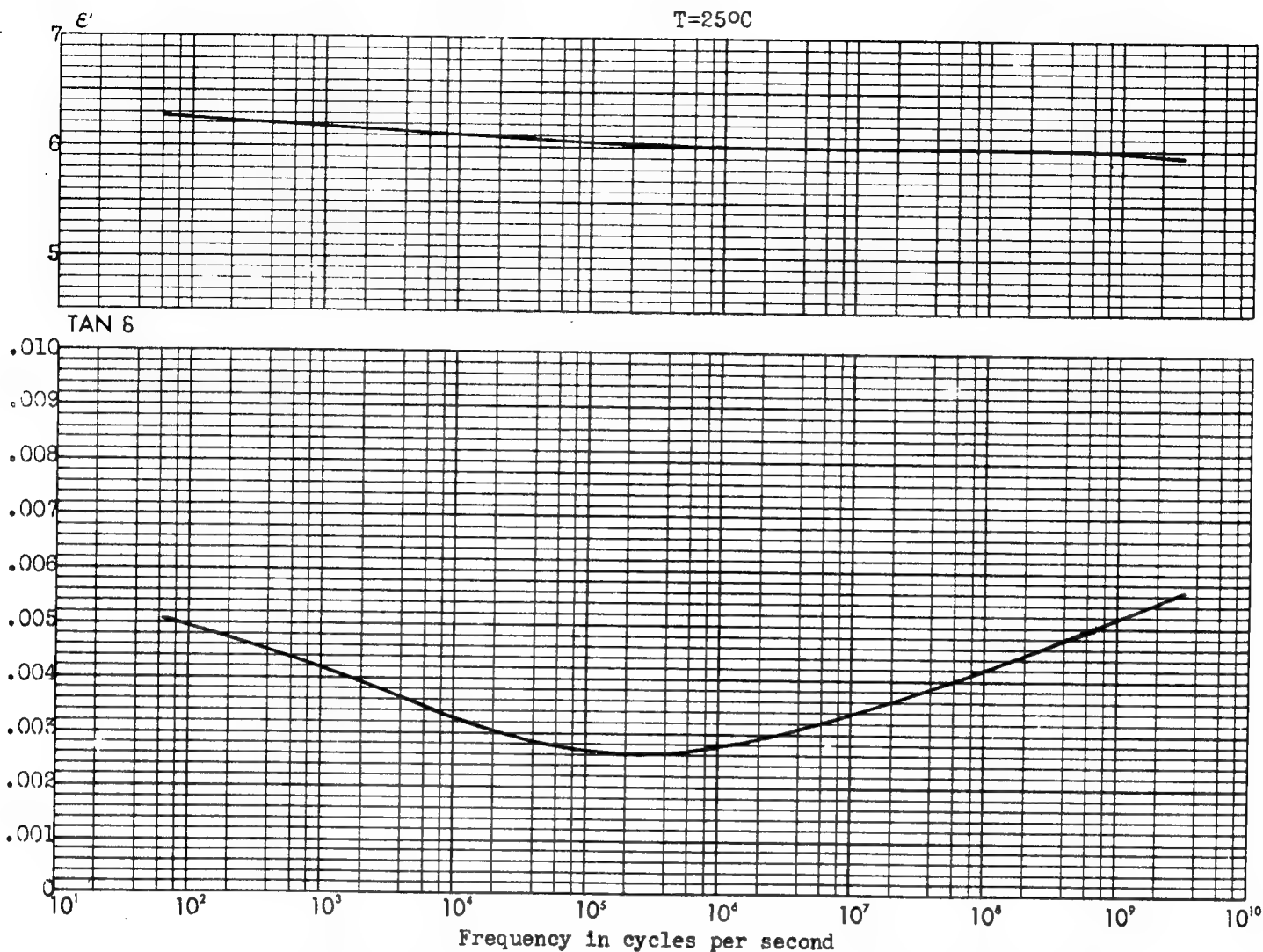
Composition: Soda-potash-lead silicate.

Properties: Colorless, clear.  $d^{25}=3.05$ . Therm. Exp.  $87 \times 10^{-7}$ .  
Tann  $431^{\circ}\text{C}$ . Tsoft  $630^{\circ}\text{C}$ . Therm. Sta.  $395^{\circ}\text{C}$ . Vol. Res.:  $9.55 \times 10^7$  at  $350^{\circ}\text{C}$ ;  
 $8.61 \times 10^8$  at  $300^{\circ}\text{C}$ ;  $1.19 \times 10^{10}$  at  $250^{\circ}\text{C}$ .  $n_D=1.557$ .

Methods of Handling: Seals to Platinum, Dumet, Sylvania #4 and Corning glasses #001, #008 and #010.

Recommended Uses: Where lead containing glass with high expansion and high resistance is desired.

Availability: Commercial production.



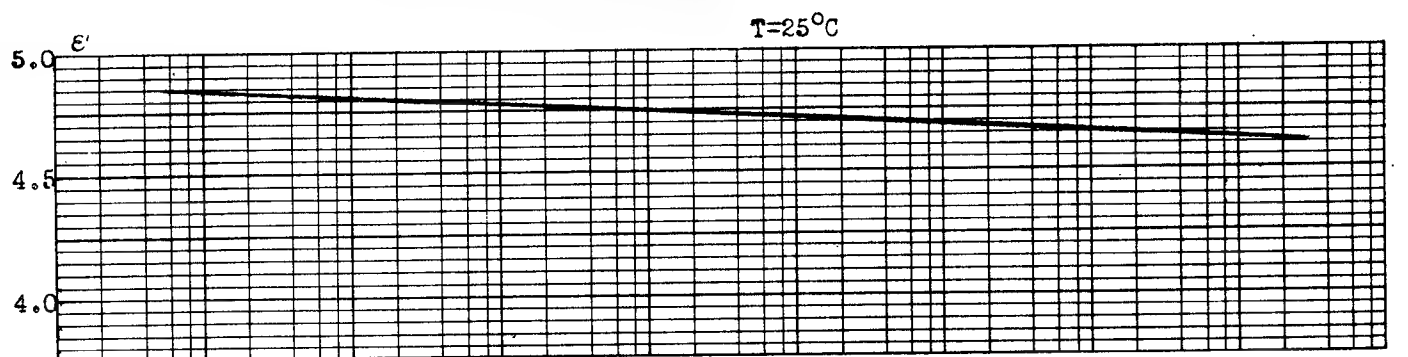
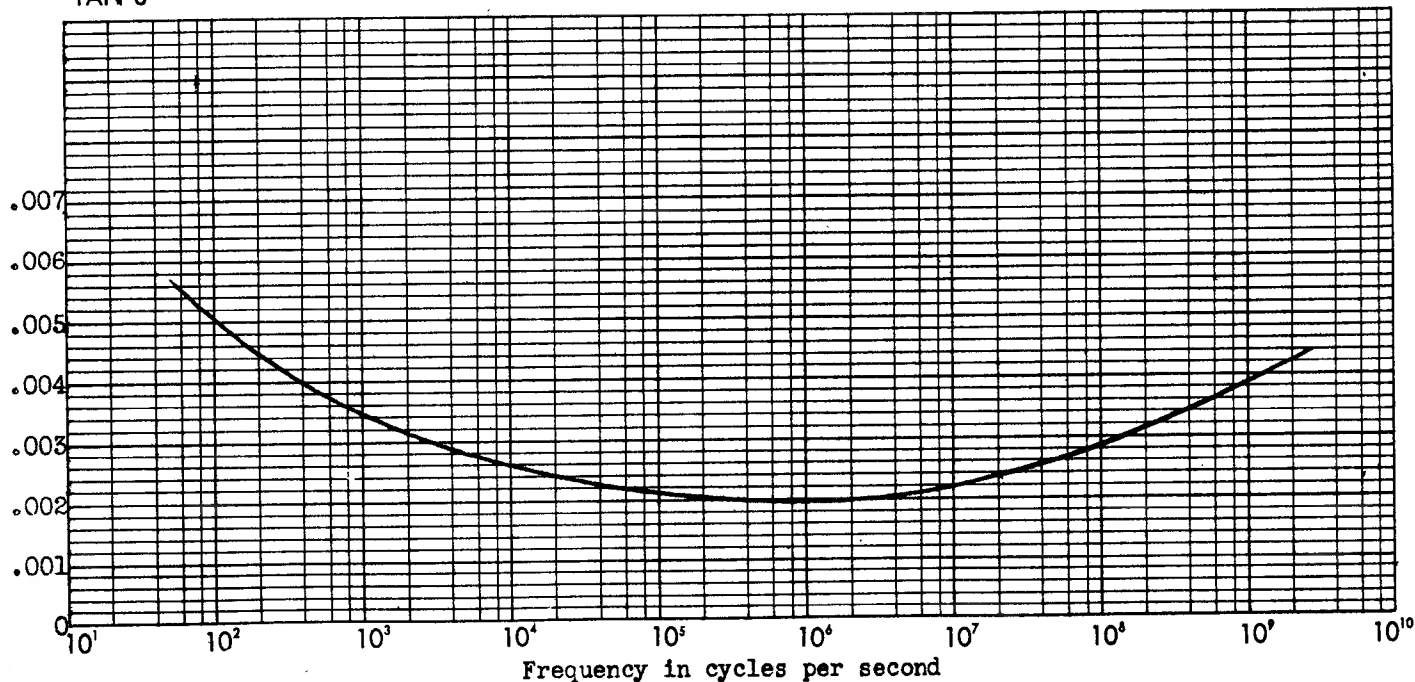
Composition: Practically alkali free, lime-alumina-silicate plus trace of color.

Properties: Bluish tinge, clear.  $d^{25}=2.53$ . Therm. Exp.  $41 \times 10^{-7}$ .  
 $T_{\text{ann}} 716^{\circ}\text{C}$ .  $T_{\text{soft}} 925^{\circ}\text{C}$ . Therm. Sta.  $679^{\circ}\text{C}$ . Vol. Res.:  $2.85 \times 10^9$  at  $350^{\circ}\text{C}$ ;  
 $2.99 \times 10^{10}$  at  $300^{\circ}\text{C}$ ;  $4.90 \times 10^{11}$  at  $250^{\circ}\text{C}$ .  $n_D=1.54$ .

Methods of Handling: Seals to Tungsten and Corning glasses #705, #707, #772, #775 and #3320.

Recommended Uses: Where high temperature, low expansion and high resistance are desired.

Availability: Commercial production.

TAN  $\delta$ 

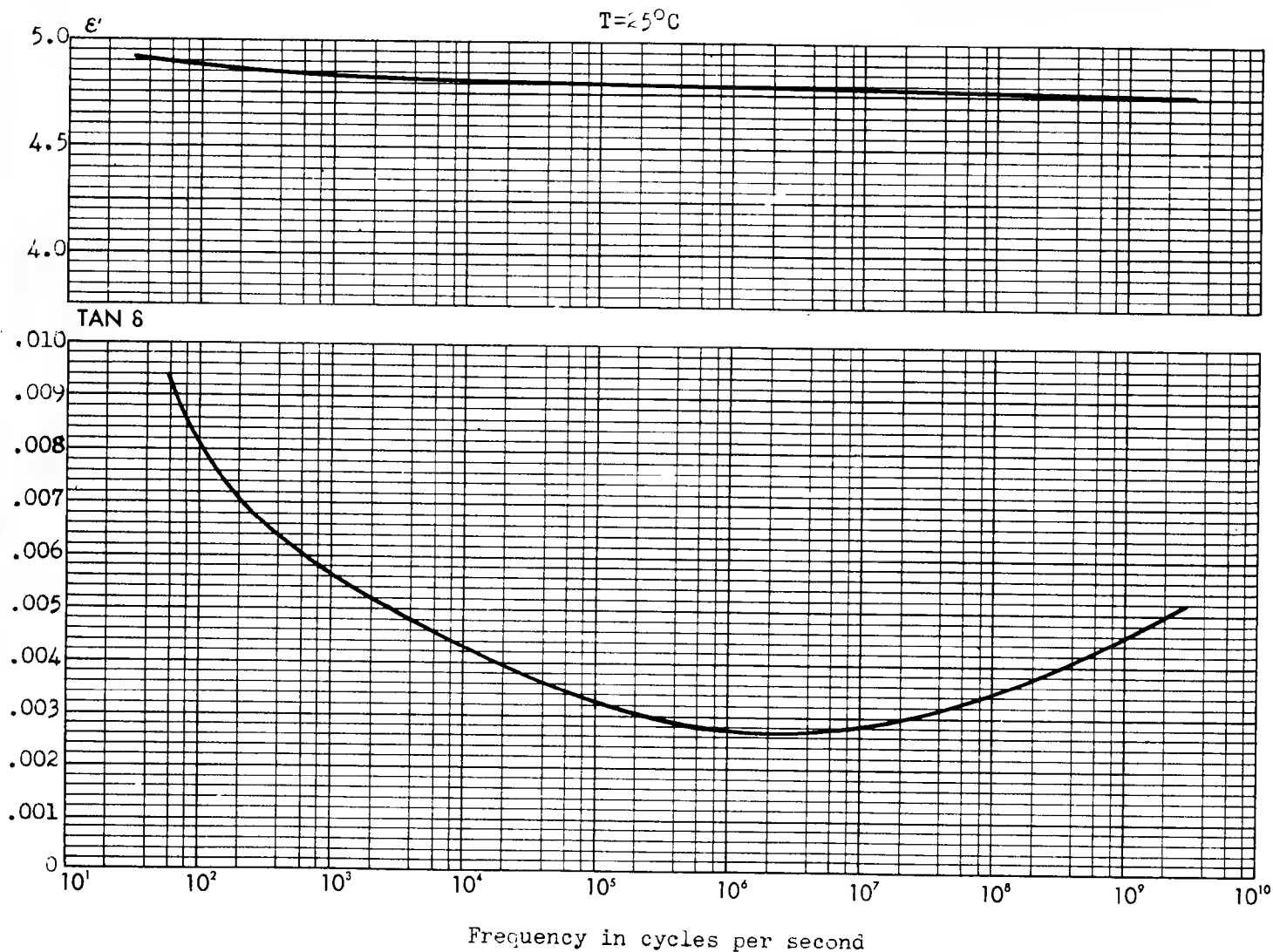
Composition: Soda-potash-borosilicate.  $\text{SiO}_2$  (ca. 70%).

Properties: Colorless, clear.  $d^{25}=2.24$ . Therm. Exp.  $49 \times 10^{-7}$ .  
 Tann  $484^{\circ}\text{C}$ . Tsoft  $697^{\circ}\text{C}$ . Therm. Sta.  $450^{\circ}\text{C}$ . Vol. Res.:  $8.80 \times 10^7$  at  $350^{\circ}\text{C}$ ;  
 $5.69 \times 10^8$  at  $300^{\circ}\text{C}$ ;  $5.31 \times 10^9$  at  $250^{\circ}\text{C}$ .  $n_D=1.480$ .

Methods of Handling: Seals to Kovar, Fernico, Molybdenum and Corning glasses  
 #775, #705, #706 and #7052.

Recommended Uses: Sealing to metals.

Availability: Commercial production.



Composition: Soda-borosilicate.  $\text{SiO}_2$  (ca. 70%).

Properties: Colorless, clear.  $d^{25}=2.23$ . Therm. Exp.  $46 \times 10^{-7}$ .

$T_{\text{ann}} 496^{\circ}\text{C}$ .  $T_{\text{soft}} 703^{\circ}\text{C}$ . Therm. Sta.  $461^{\circ}\text{C}$ . Vol. Res.:  $5.89 \times 10^6$  at  $350^{\circ}\text{C}$ ;  $2.98 \times 10^7$  at  $300^{\circ}\text{C}$ ;  $2.04 \times 10^8$  at  $250^{\circ}\text{C}$ .  $n_D=1.479$ .

Methods of Handling: Seals to Kovar, Fernico, Molybdenum, Tungsten and Corning glasses #704, #707, #7052, #772, #3320, #775, #171 and #706.

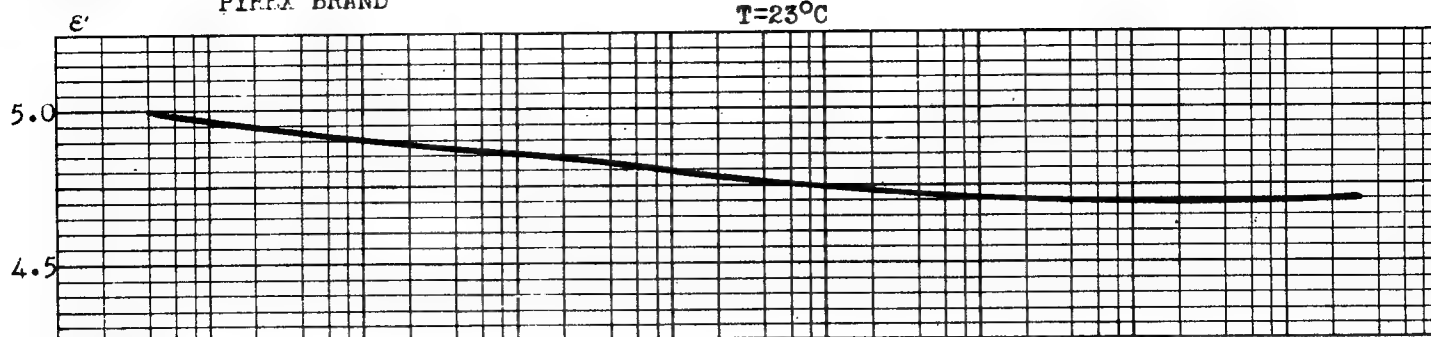
Recommended Uses: Sealing to metals and glasses.

Availability: Commercial production.

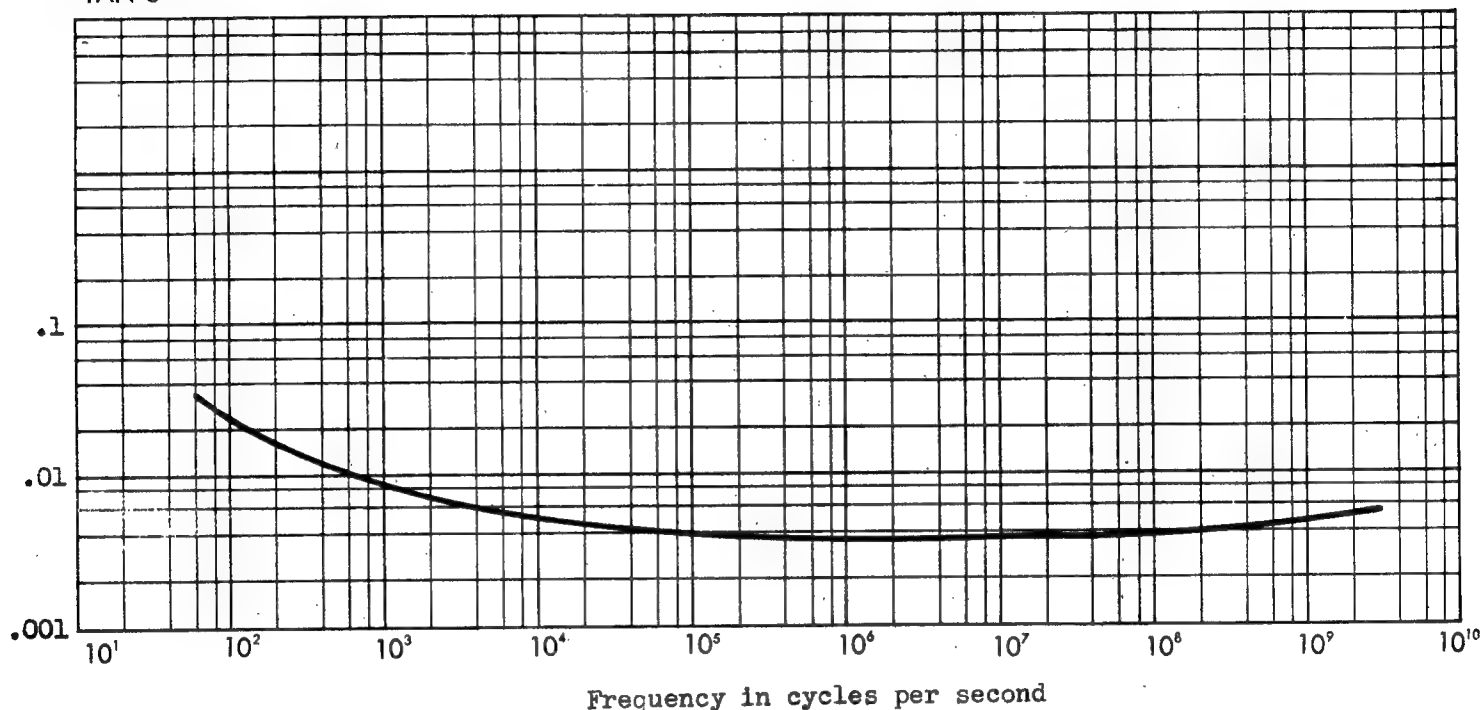
CORNING GLASS #706 (Corning Lab. No. 705A0)  
PYREX BRAND

CORNING GLASS WORKS

T=23°C



TAN δ



Frequency in cycles per second

Composition: Soda-borosilicate

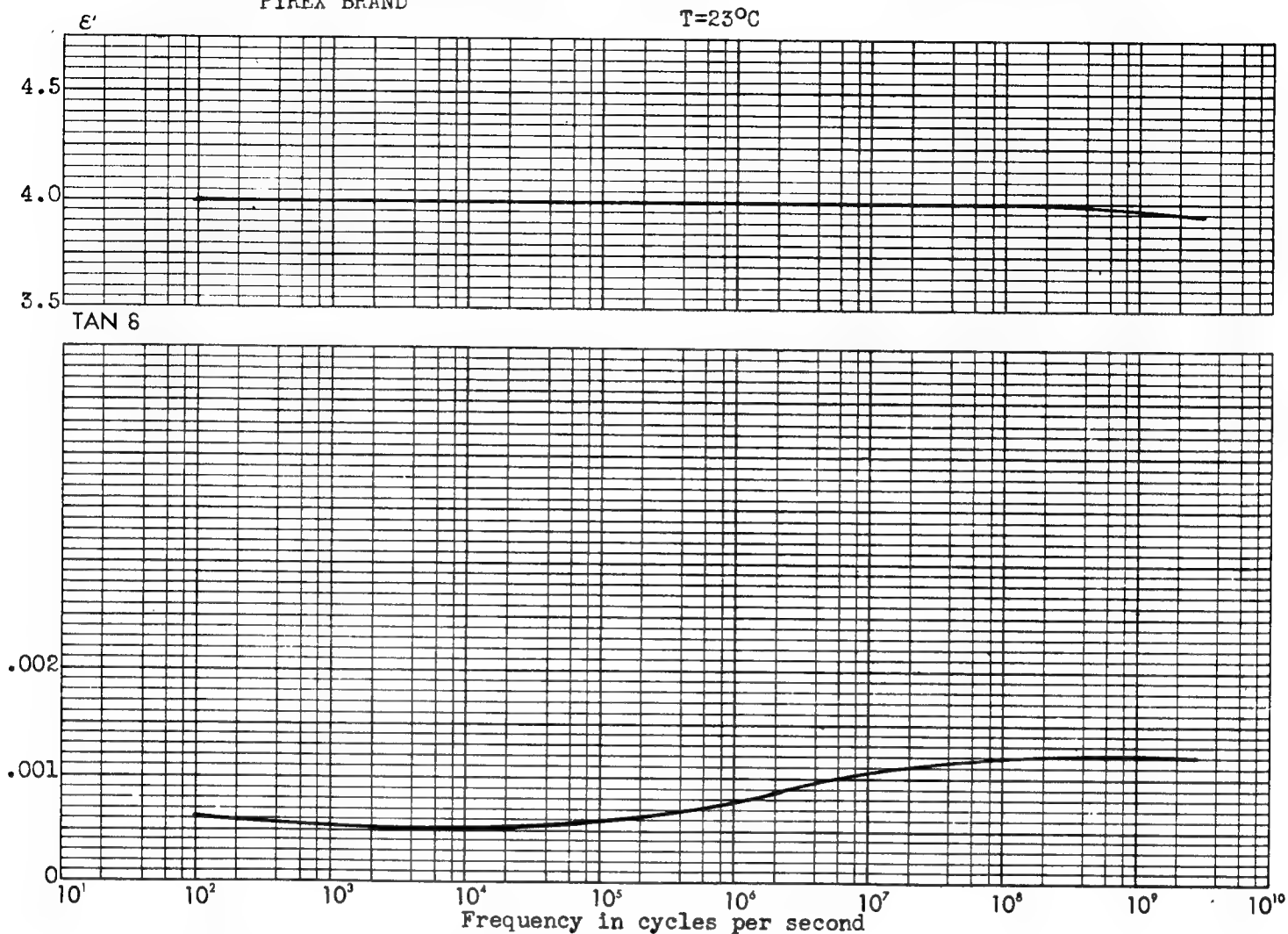
Properties: Colorless, clear.  $d^{25}=2.25$ . Therm. Exp.  $50 \times 10^{-7}$ .  
Tann  $494^{\circ}\text{C}$ . Tsoft  $695^{\circ}\text{C}$ . Therm. Sta.  $459^{\circ}\text{C}$ . Vol. Res.:  $2.57 \times 10^6$  at  $350^{\circ}\text{C}$ ;  
 $6.68 \times 10^7$  at  $250^{\circ}\text{C}$ .  $n_D=1.482$ .

Methods of Handling: Seals to Fernico, Kovar, Molybdenum and to Corning glasses  
#704, #705, #7052 and #775.

Recommended Uses: Sealing to metals and glasses.

Availability: Commercial production.





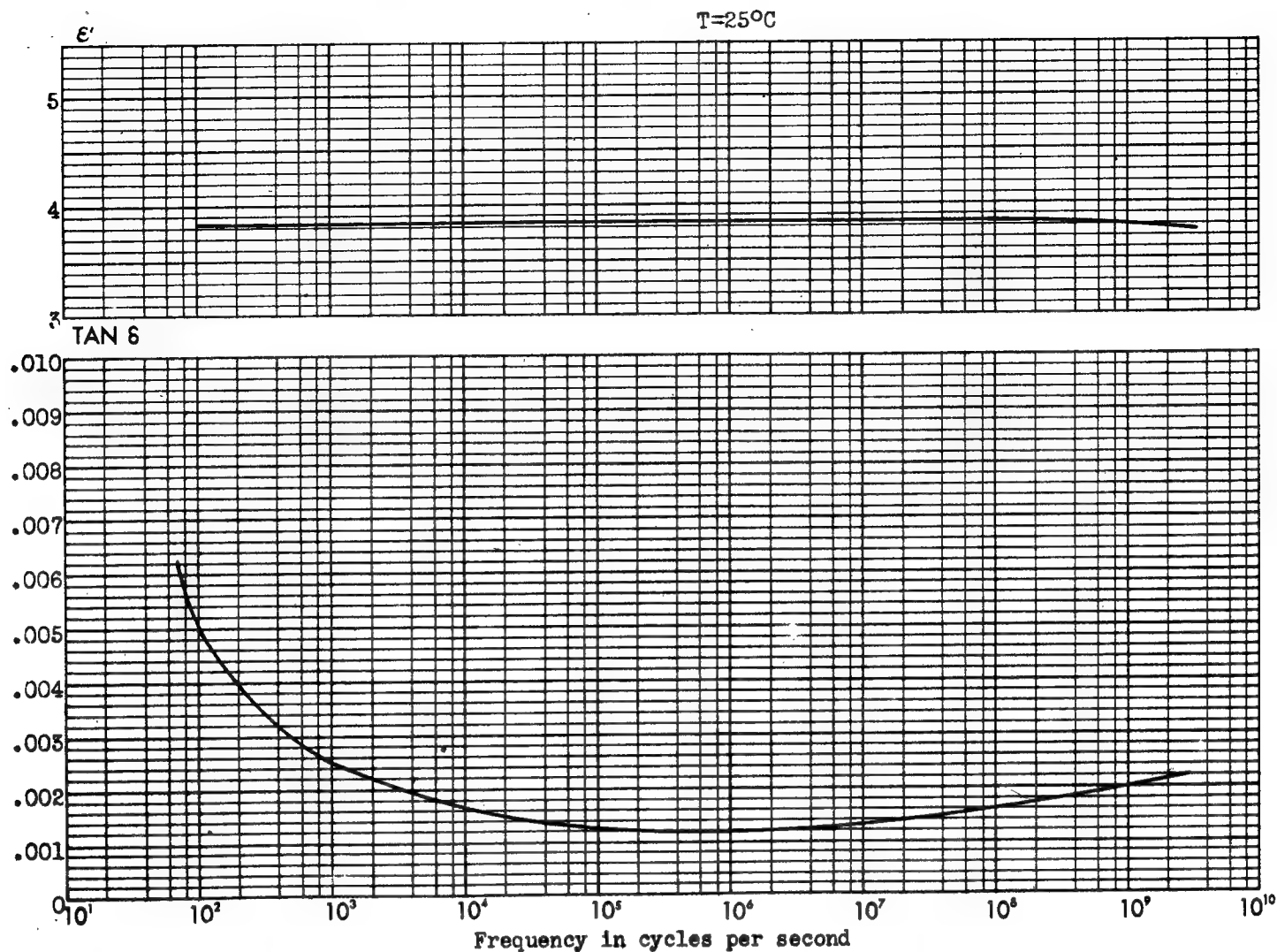
Composition: Low alkali, potash-lithia borosilicate.

Properties: Colorless, clear.  $d_{25}^{25}=2.13$ . Therm. Exp.  $31 \times 10^{-7}$ .  
Tann  $490^{\circ}\text{C}$ . Tsoft  $746^{\circ}\text{C}$ . Therm. Sta.  $435^{\circ}\text{C}$ . Vol. Res.:  $1.30 \times 10^9$  at  $350^{\circ}\text{C}$ ;  
 $1.14 \times 10^{10}$  at  $300^{\circ}\text{C}$ ;  $1.50 \times 10^{11}$  at  $250^{\circ}\text{C}$ .  $n_D=1.469$ .

Methods of Handling: Seals to Tungsten and Corning glasses #705, #774, #772, #3320, #775 and #171.

Recommended Uses: Where low loss glass is required.

Availability: Commercial production.



Composition: Aluminum-borosilicate.

Properties: Colorless, clear. Therm. Exp.  $14 \times 10^{-7}$ .  $T_{\text{ann}} 750^{\circ}\text{C}$ .  
 $T_{\text{soft}} 1160^{\circ}\text{C}$ . Therm. Sta.  $675^{\circ}\text{C}$ .

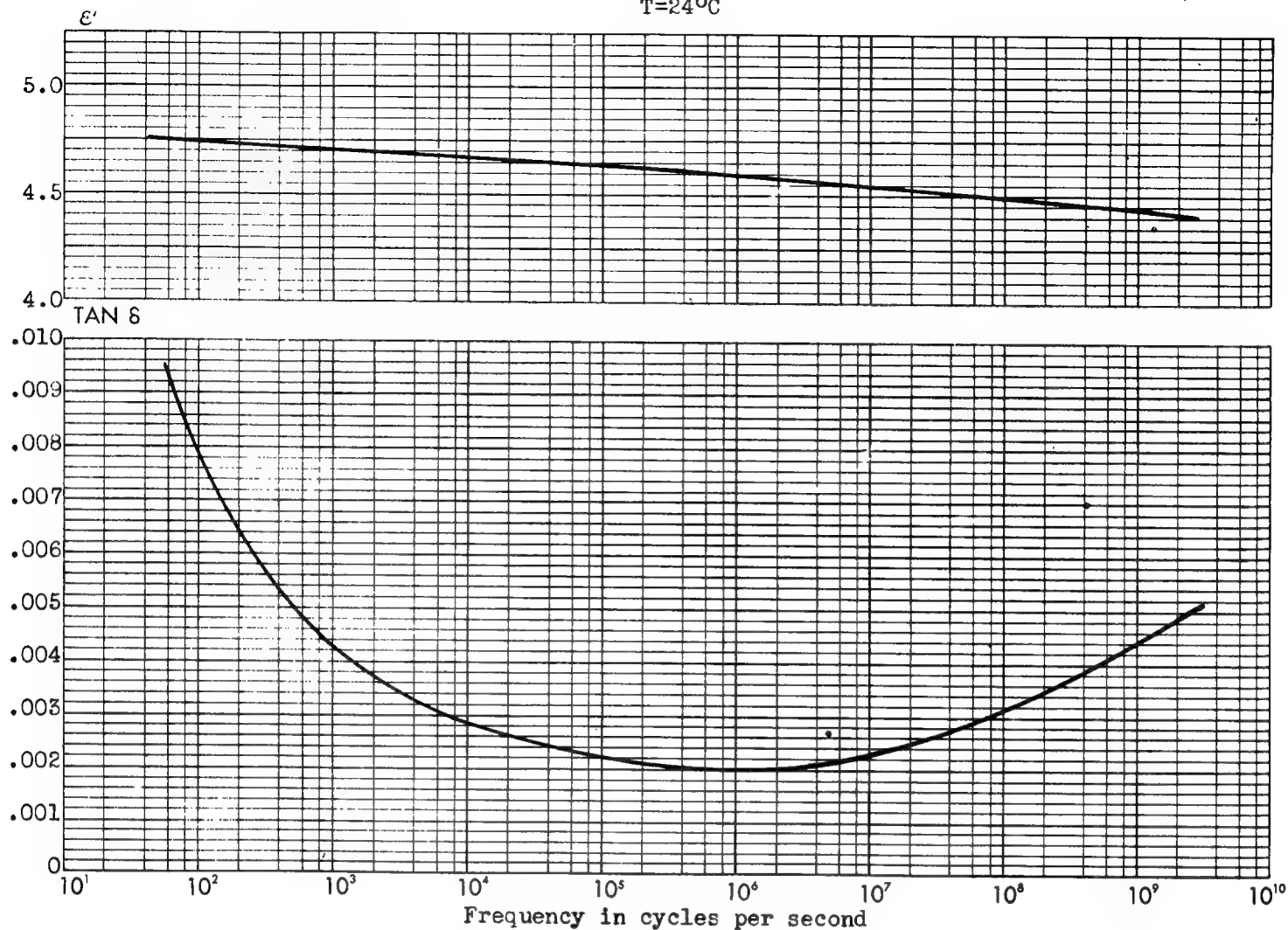
Methods of Handling: For small Tungsten seals and sealing to silica and Corning glass #790.

Recommended Uses: Intermediate seal to Corning glass #790 and  $\text{SiO}_2$ .

Availability: Commercial production.

PYREX BFAND

T=24°C



Composition: Soda-lead-borosilicate.

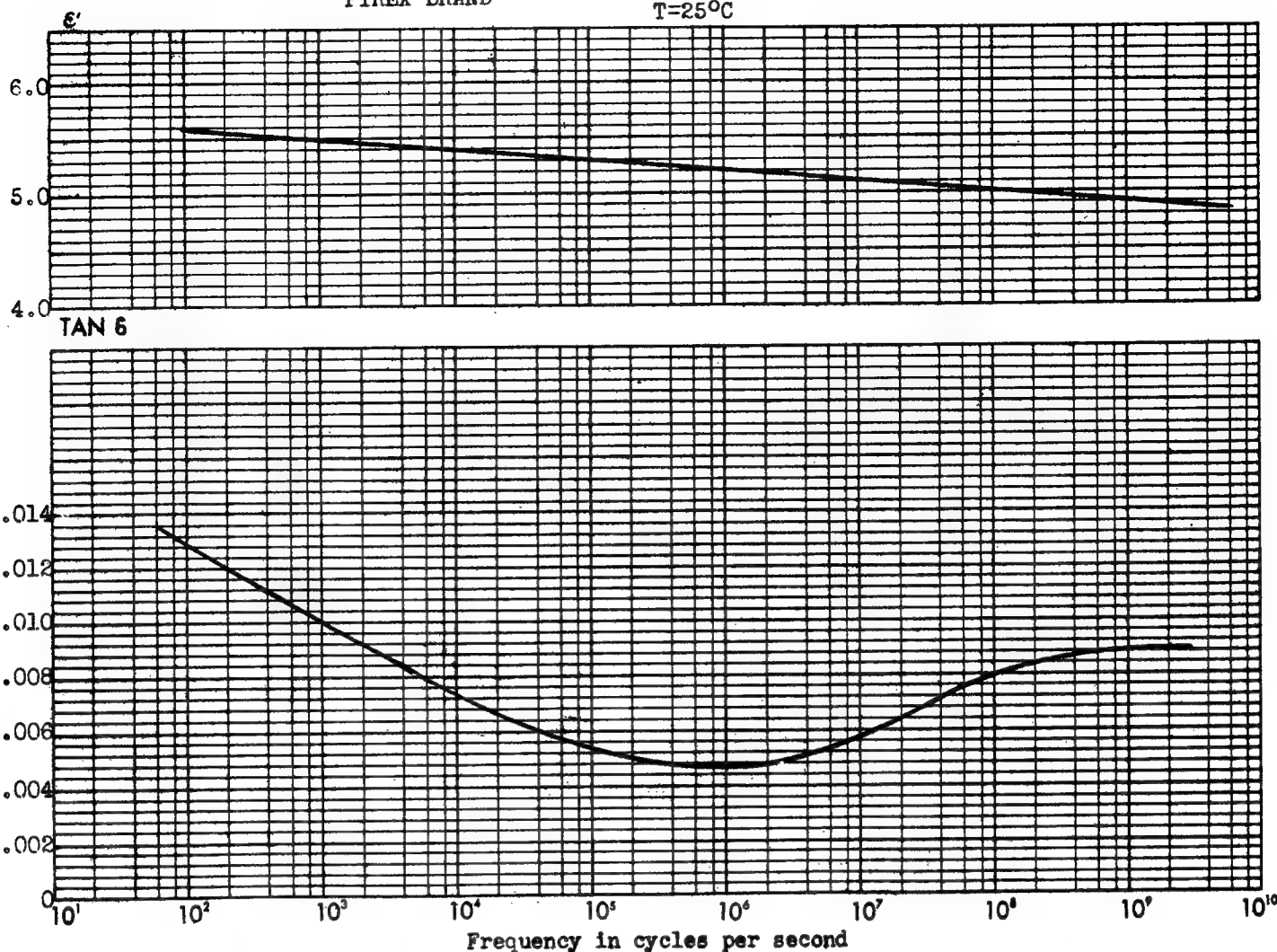
Properties: Colorless, clear.  $d^{25}=2.35$ . Therm. Exp.  $36 \times 10^{-7}$ .  
 $T_{\text{ann}} 526^\circ\text{C}$ .  $T_{\text{soft}} 756^\circ\text{C}$ . Therm. Sta.  $494^\circ\text{C}$ . Vol. Res.:  $1.59 \times 10^7$  at  $350^\circ\text{C}$ ;  
 $8.57 \times 10^7$  at  $300^\circ\text{C}$ ;  $6.53 \times 10^8$  at  $250^\circ\text{C}$ .  $n_D = 1.489$ .

Methods of Handling: Seals to Tungsten and Corning glasses #705, #707, #774, #3320, #775 and #171.

Recommended Uses: Tungsten sealing.

Availability: Commercial production.

T=25°C



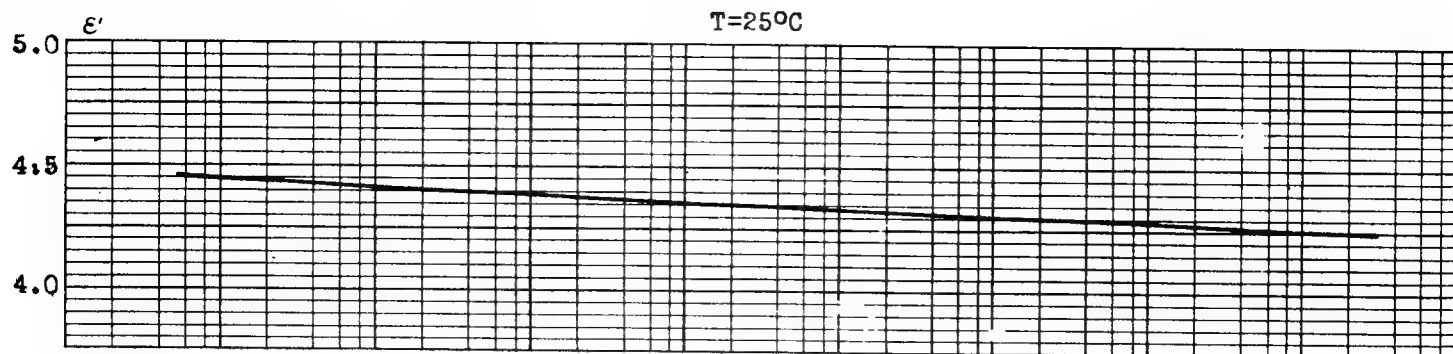
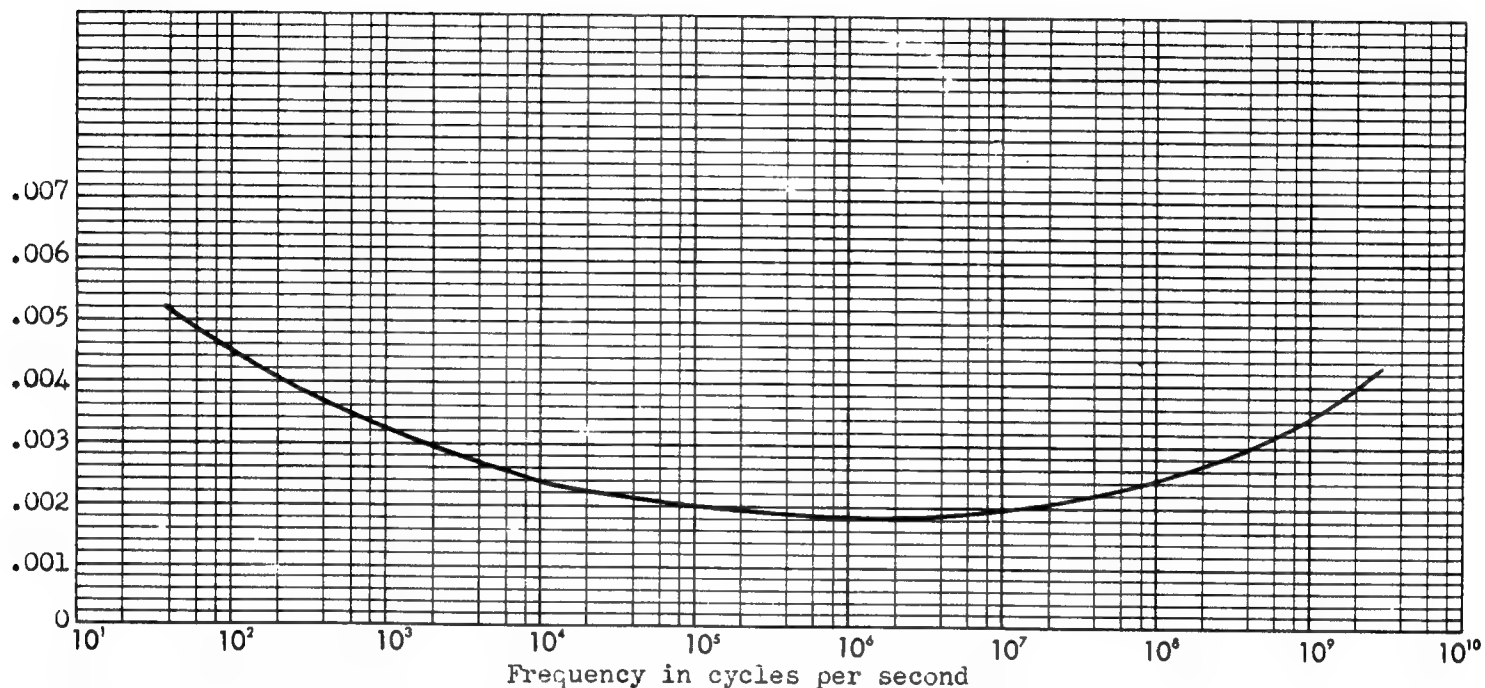
Composition: Soda-borosilicate (ca. 80%  $\text{SiO}_2$ ).

Properties: Colorless, clear.  $d^{25}=2.25$ . Therm. Exp.  $33 \times 10^{-7}$ .  
 $T_{\text{ann}} 553^\circ\text{C}$ .  $T_{\text{soft}} 819^\circ\text{C}$ . Therm. Sta.  $510^\circ\text{C}$ . Vol. Res.:  $4.73 \times 10^6$  at  $350^\circ\text{C}$ ;  
 $2.24 \times 10^7$  at  $300^\circ\text{C}$ ;  $1.41 \times 10^8$  at  $250^\circ\text{C}$ .  $n_D=1.474$ .

Methods of Handling: For small Tungsten seals and sealing to Corning glasses #707 and #772.

Recommended Uses: General low expansion glass. Pyrex Brand chemical glass.

Availability: Commercial production.

TAN  $\delta$ 

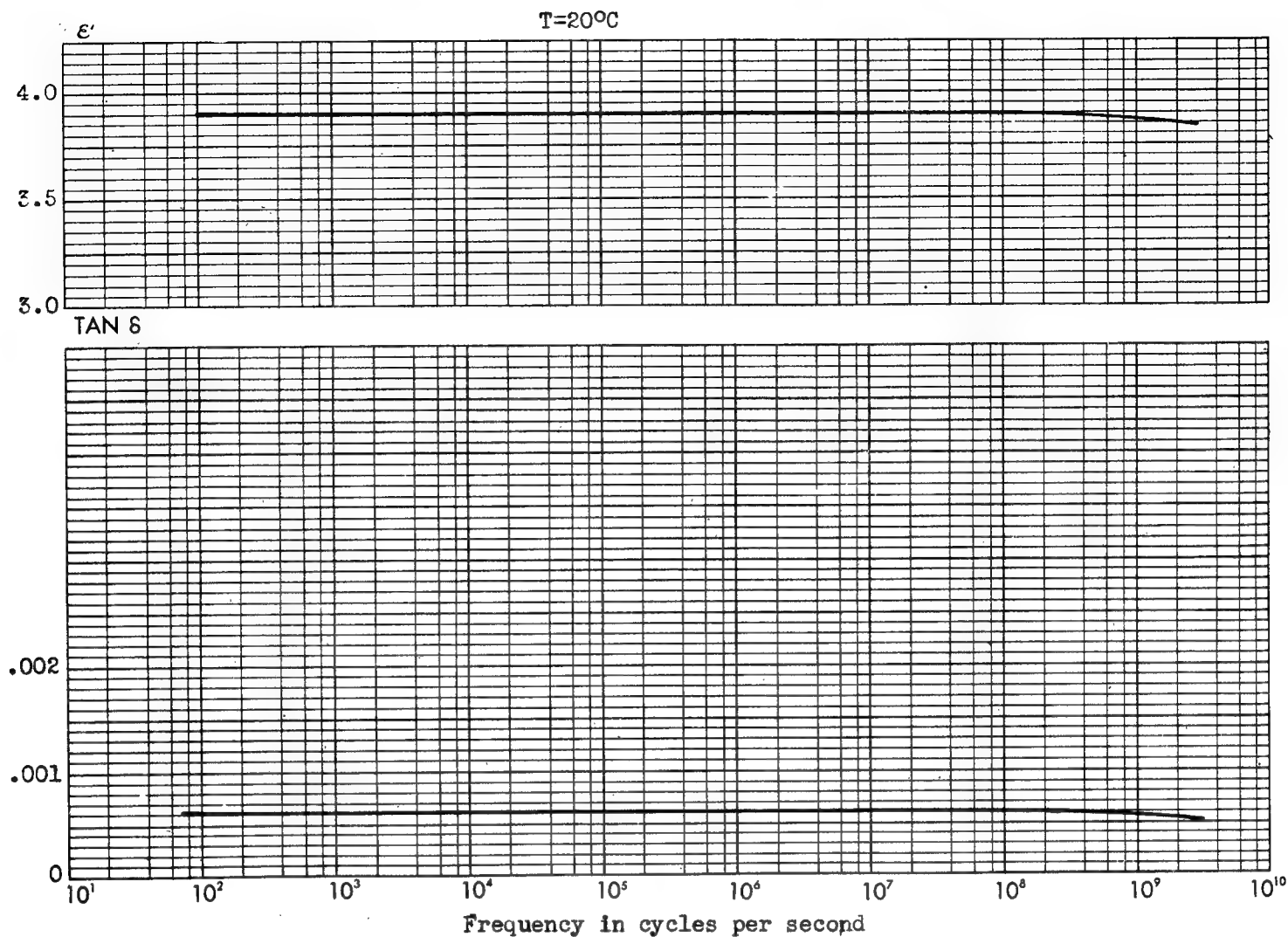
Composition: Soda-borosilicate, higher  $B_2O_3$  than Corning #705.

Properties: Colorless, clear.  $d^{25}_D=2.197$ . Therm. Exp.  $42 \times 10^{-7}$ .  
 Tann  $467^\circ\text{C}$ . Tsoft  $701^\circ\text{C}$ . Therm. Sta.  $431^\circ\text{C}$ . Vol. Res.:  $5.31 \times 10^7$  at  $350^\circ\text{C}$ ;  
 $3.27 \times 10^8$  at  $300^\circ\text{C}$ ;  $2.88 \times 10^9$  at  $250^\circ\text{C}$ .  $n_D=1.474$ .

Methods of Handling: Seals to Tungsten and Corning glasses #772, #704, #705, #7052, #706, #707, #3320 and #171.

Recommended Uses: Intermediate glass sealing.

Availability: Commercial production.



Composition:  $\text{SiO}_2$  (96%).

Properties: Colorless, clear.  $d^{25}=2.18$ . Therm. Exp.  $8 \times 10^{-7}$ .  
Tann  $930^\circ\text{C}$ . Tsoft  $1450^\circ\text{C}$ . Therm. Sta.  $860^\circ\text{C}$ . Vol. Res.:  $1.29 \times 10^8$  at  $350^\circ\text{C}$ ;  
 $5.19 \times 10^9$  at  $250^\circ\text{C}$ .  $n_D=1.458$ .

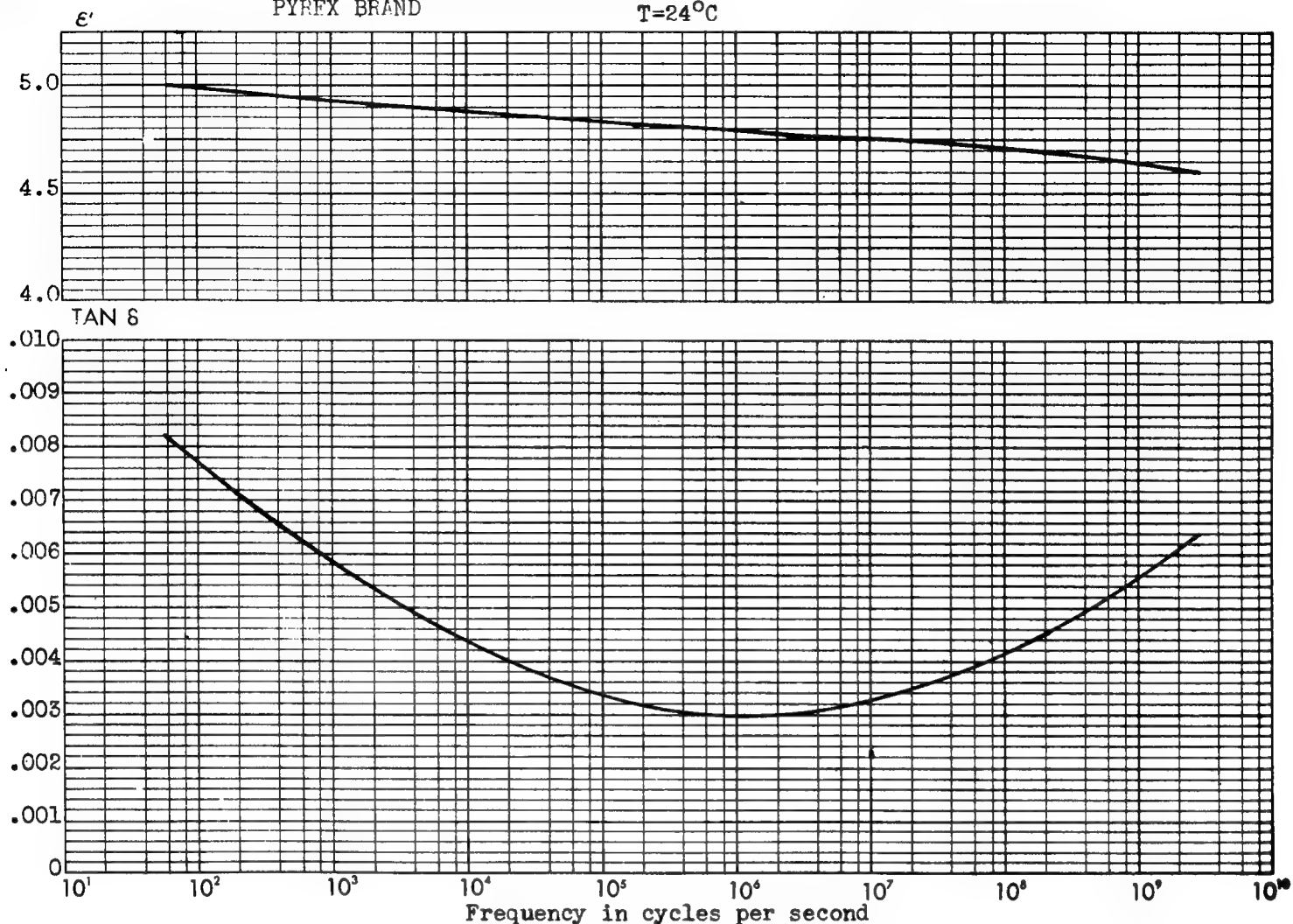
Methods of Handling: Seals to Corning glass #723 and  $\text{SiO}_2$ .

Recommended Uses: When glass with low loss and low expansion is required. Useful at high temperature.

Availability: Commercial production.

PYREX BRAND

T=24°C



Composition: Soda-potash-borosilicate, plus color.

Properties: Yellow-green, clear.  $d^{25}=2.29$ . Therm. Exp.  $41 \times 10^{-7}$ .  
 Tann  $536^\circ\text{C}$ . Tsoft  $788^\circ\text{C}$ . Therm. Sta.  $501^\circ\text{C}$ . Vol. Res.:  $1.14 \times 10^7$  at  $350^\circ\text{C}$ ;  
 $5.89 \times 10^7$  at  $300^\circ\text{C}$ ;  $4.17 \times 10^8$  at  $250^\circ\text{C}$ .  $n_D=1.481$ .

Methods of Handling: Seals to Tungsten and Corning glasses #772, #705, #707, #775, #171 and #774.

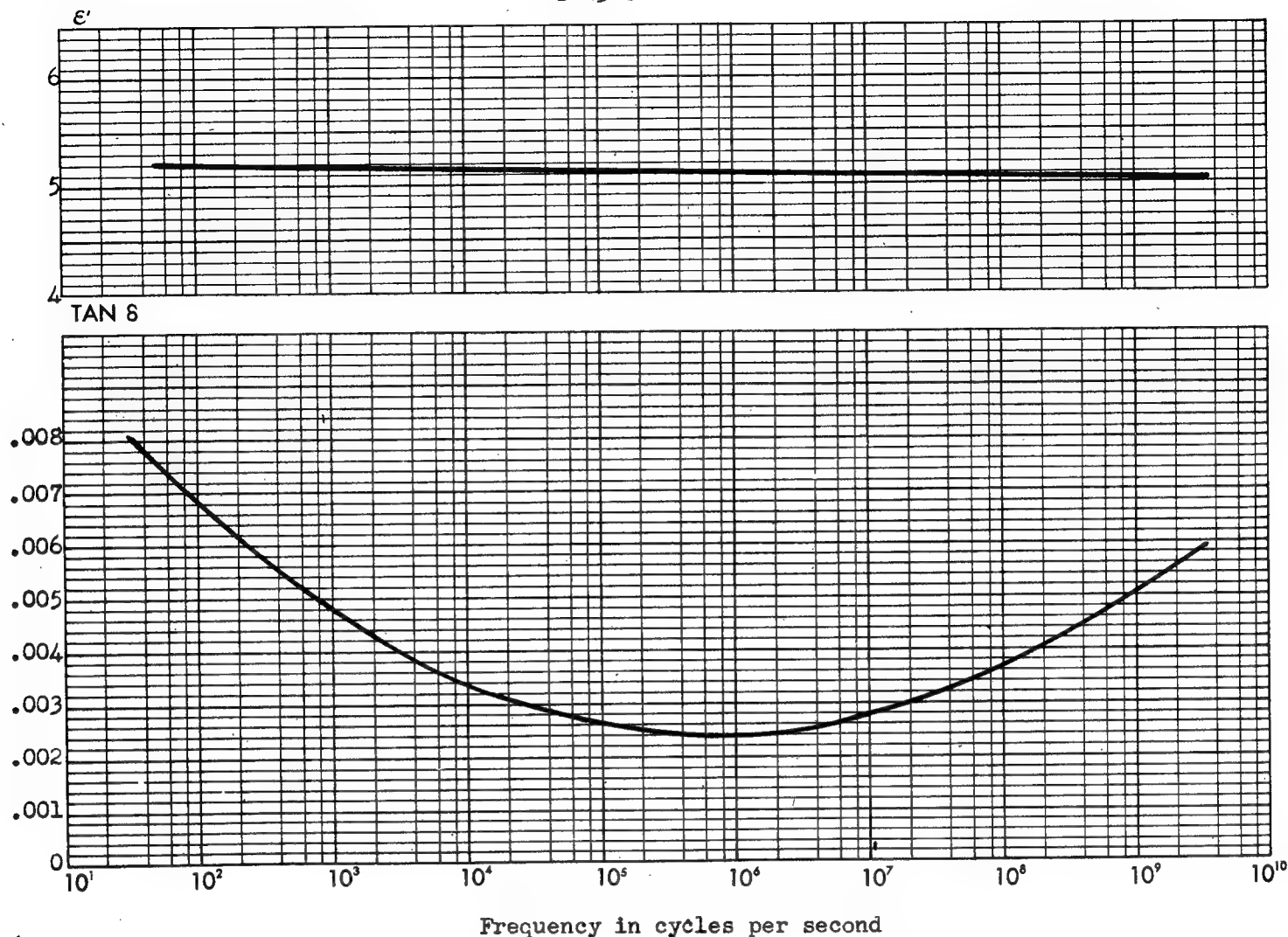
Recommended Uses: Used as an intermediate seal for Corning glass #772 and Corning glass #774.

Availability: Commercial production.



PYREX BRAND

T=23°C



Composition: Soda-potash-lithia-borosilicate; relatively high  $\text{Al}_2\text{O}_3$ .

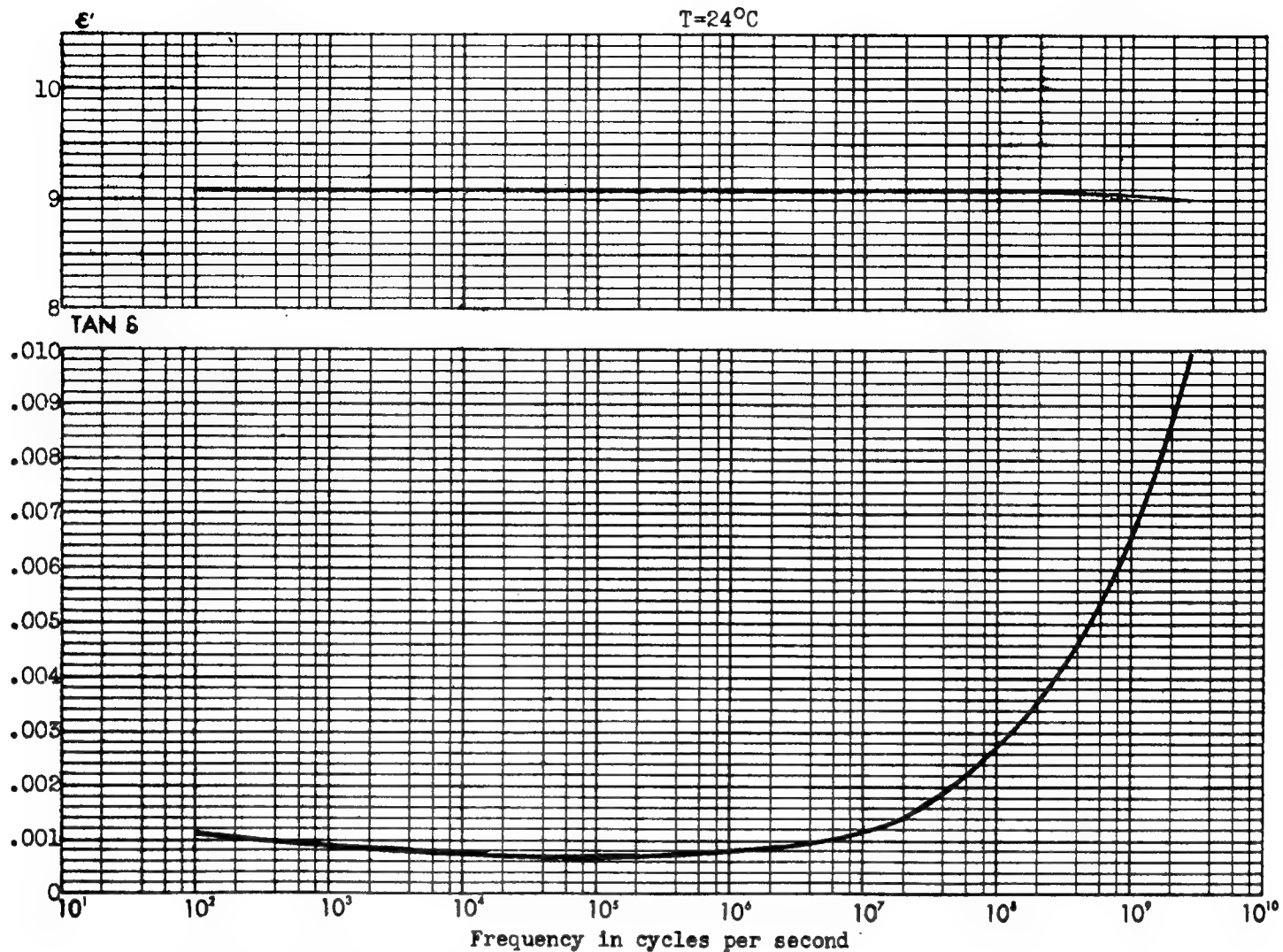
Properties: Yellow-green tinge, clear.  $d^{25}=2.31$ . Therm. Exp.  $47 \times 10^{-7}$ .  
 Tann  $481^\circ\text{C}$ . Tsoft  $710^\circ\text{C}$ . Therm. Sta.  $444^\circ\text{C}$ . Vol. Res.:  $2 \times 10^7$  at  $350^\circ\text{C}$ ;  
 $1 \times 10^9$  at  $250^\circ\text{C}$ .  $n_D=1.484$ .

Methods of Handling: Seals to Kovar, Fernico, Molybdenum and Corning glasses  
 #704, #705, #775 and #706.

Recommended Uses: Sealing to metals.

Availability: Commercial production.



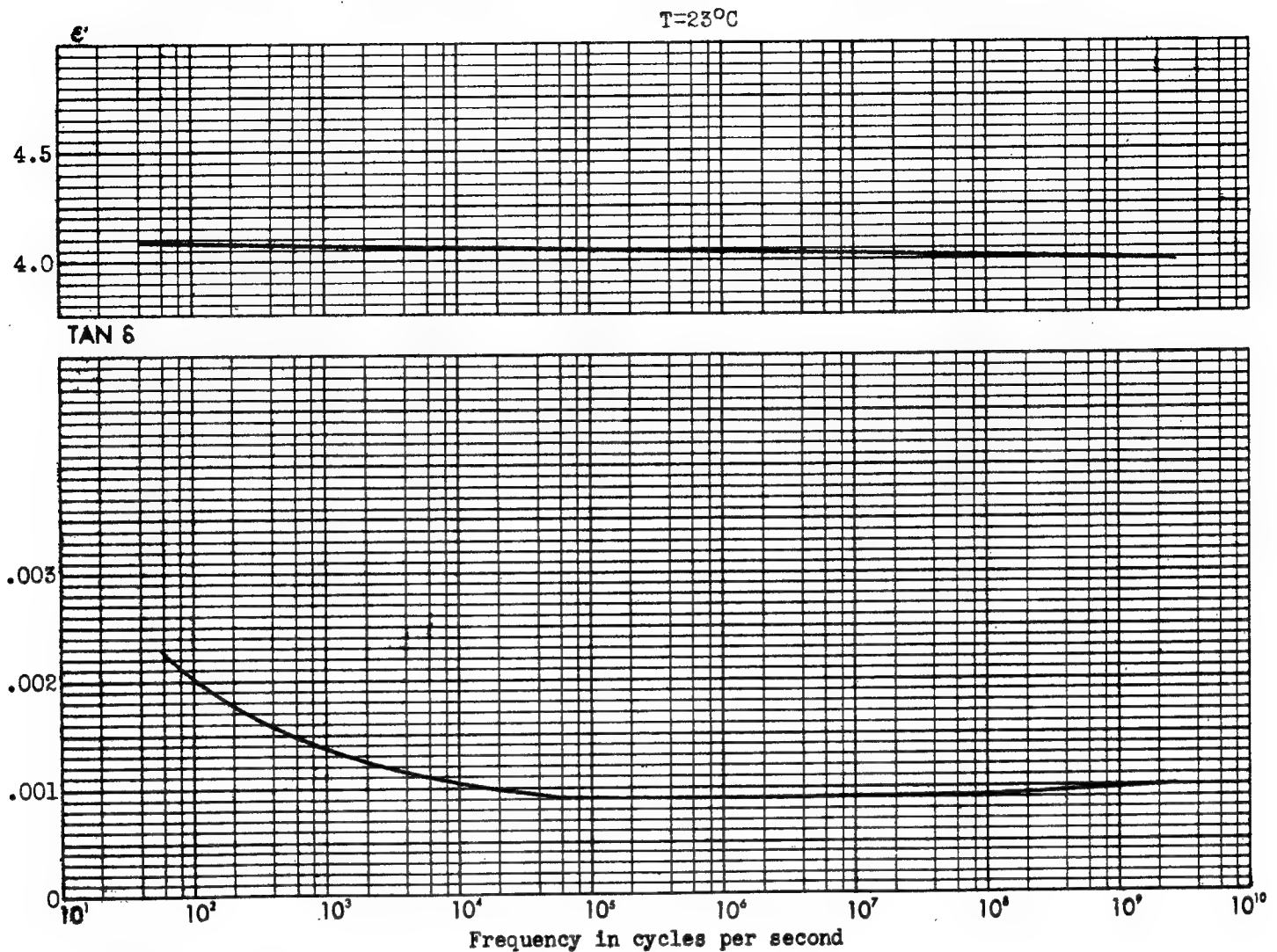


Composition: Barium-borosilicate.

Properties: Colorless, clear.  $n_D=1.62$ .

Recommended Uses: Optical glass.

Availability: Commercial production.

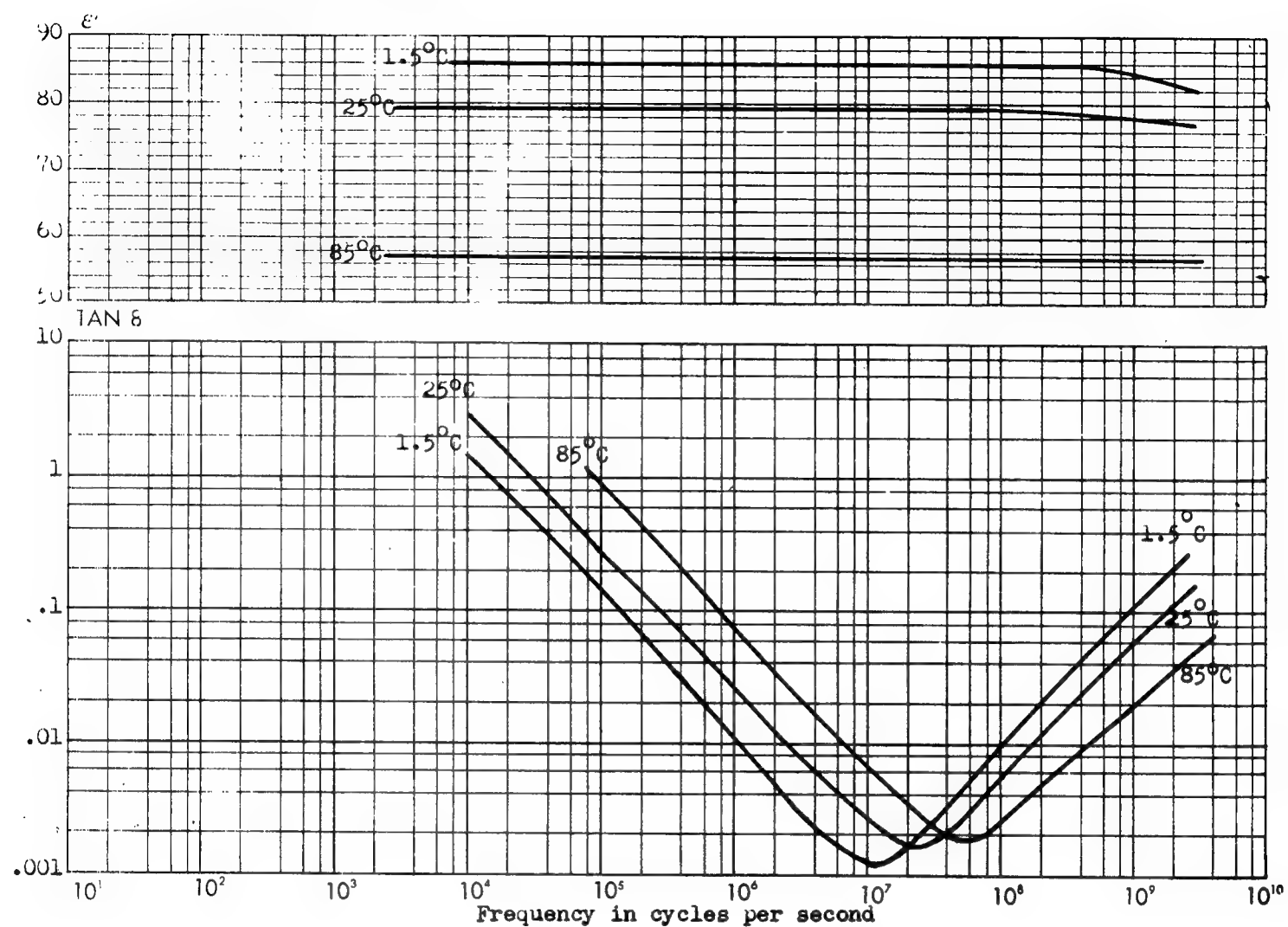


Composition: Borosilicate.

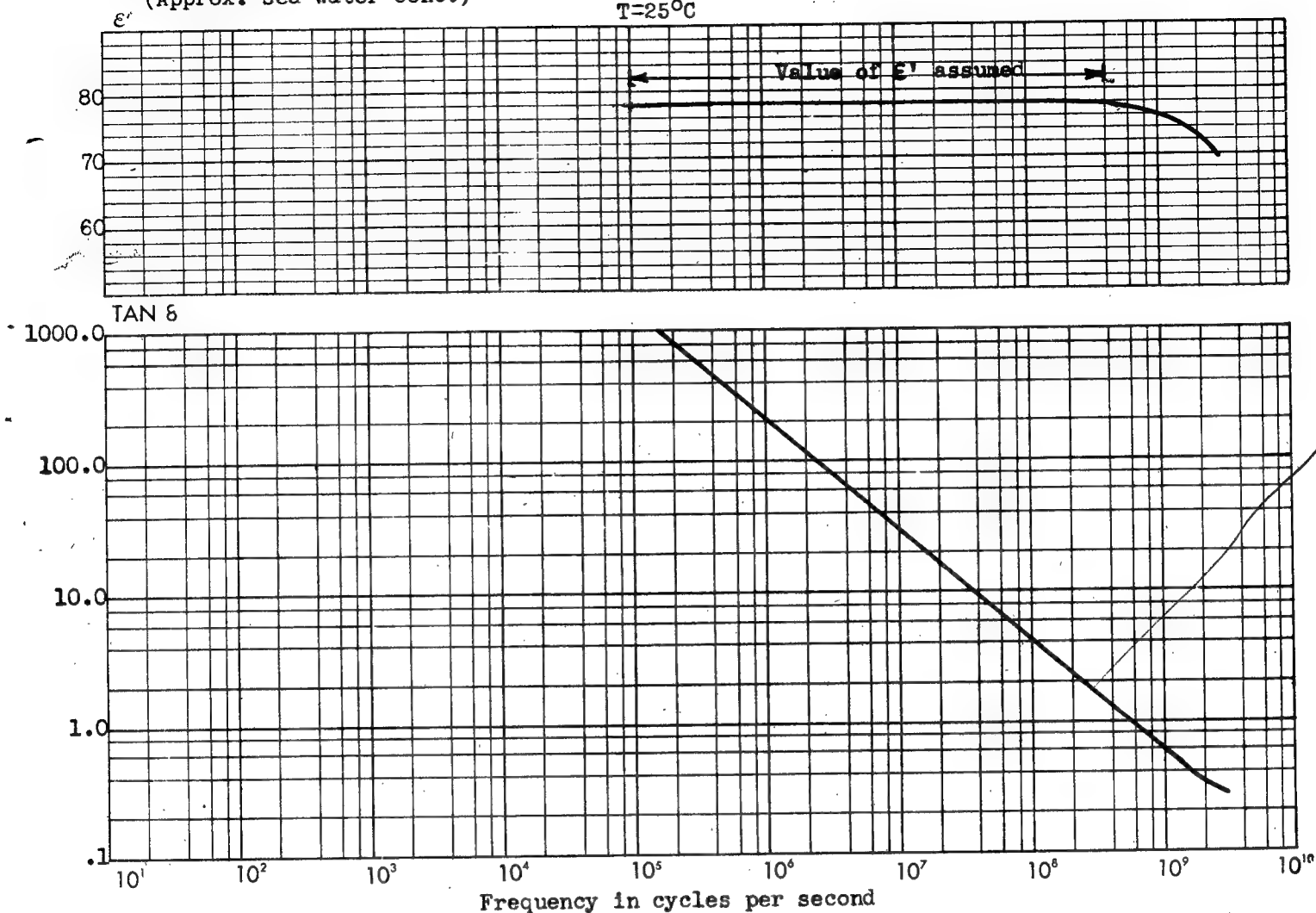
Properties: Colorless, clear.  $d^{25}_{20} = 2.154$ . Therm. Exp.  $35 \times 10^{-7}$ .  
 $T_{\text{ann}} 471^{\circ}\text{C}$ .  $T_{\text{soft}} 720^{\circ}\text{C}$ . Therm. Sta.  $420^{\circ}\text{C}$ . Vol. Res.:  $6.1 \times 10^9$  at  $350^{\circ}\text{C}$ ;  
 $1.42 \times 10^{12}$  at  $250^{\circ}\text{C}$ .

Recommended Use: Electrical insulation.

**NOTE:** This glass represents a type of low power factor glass still under development, and the finally accepted glass along this line may have a different designation and possibly somewhat different properties.

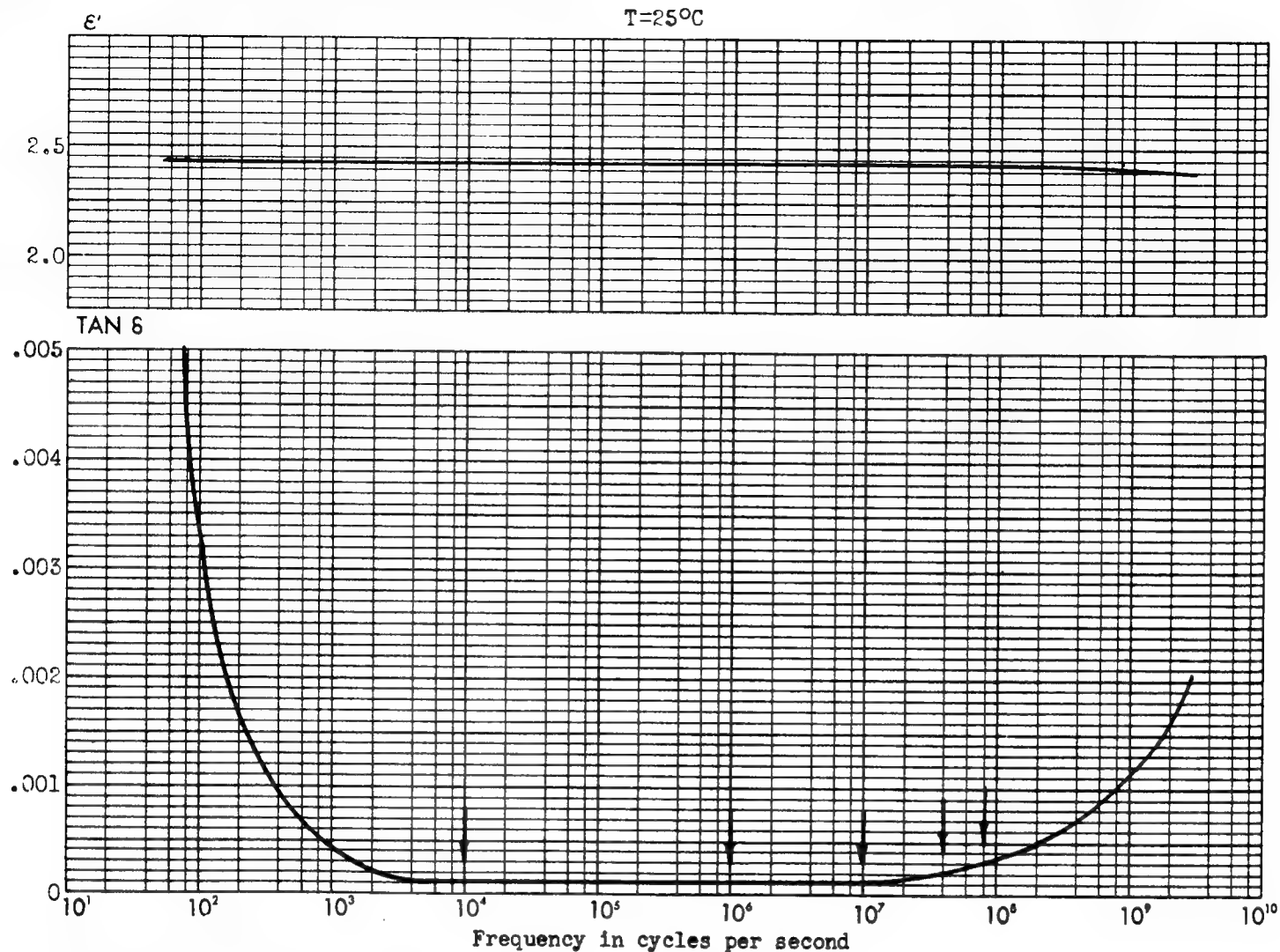


T=25°C



Chemical Name: Sodium chloride solution (2.285% NaCl)

Composition: Mallinckrodt analytical reagent sodium chloride dissolved in conductivity water from still of Research Laboratory of Physical Chemistry, M. I. T.  
Concentration .3909 molal.



Chemical Name: Vinyl benzene

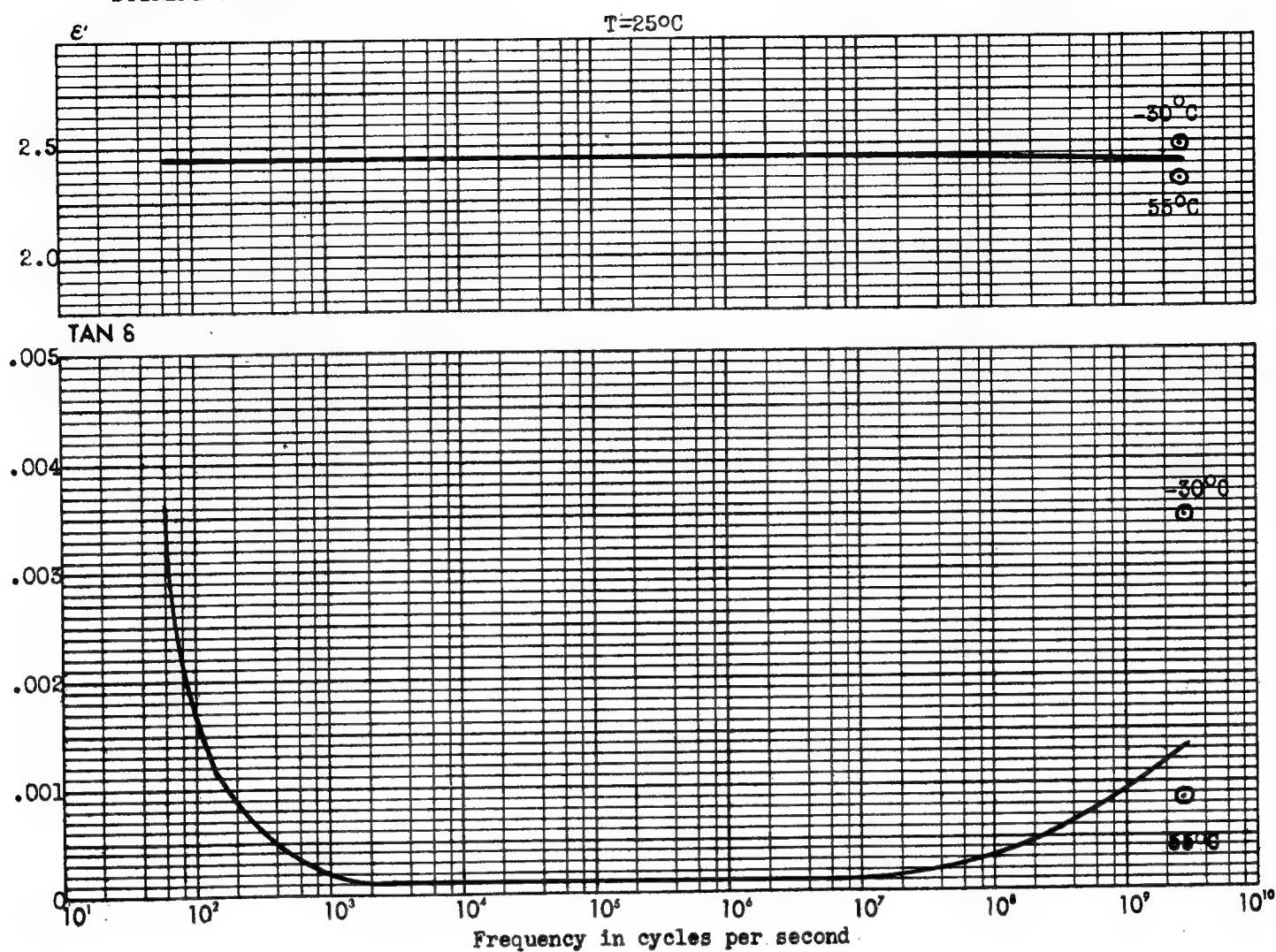
Composition: Styrene

Properties: Water white.  $d_{25}^{25}=0.905$ . M. P.  $-30.61^\circ\text{C}$ . B. P.  $145.2^\circ\text{C}$ . Flash P.  $31^\circ\text{C}$ . Fire P.  $24^\circ\text{C}$ . Spec. Heat 0.32. Heat Vap. 85. Therm. Sta.: polymerizes.  $n_D=1.5439$ . Visc.(cp.)  $60^\circ\text{C}$  ca. 0.51;  $25^\circ\text{C}$  0.77. Heat of Polymerization 192 cal./gm. Moist. Abs. 0.06%. Sun.: discolors and polymerizes. Sol.: soluble in most organic solvents; insoluble in water. Poly.: excellent. Elec. Str. 300 for 0.100" gap. Vol. Res.  $3 \times 10^{12}$ .

Precautions in Handling: Somewhat less toxic than other aromatics such as benzene.

Recommended Uses: Preparation of polystyrene and styrene copolymers. Raw material for chemical synthesis. Solvent.

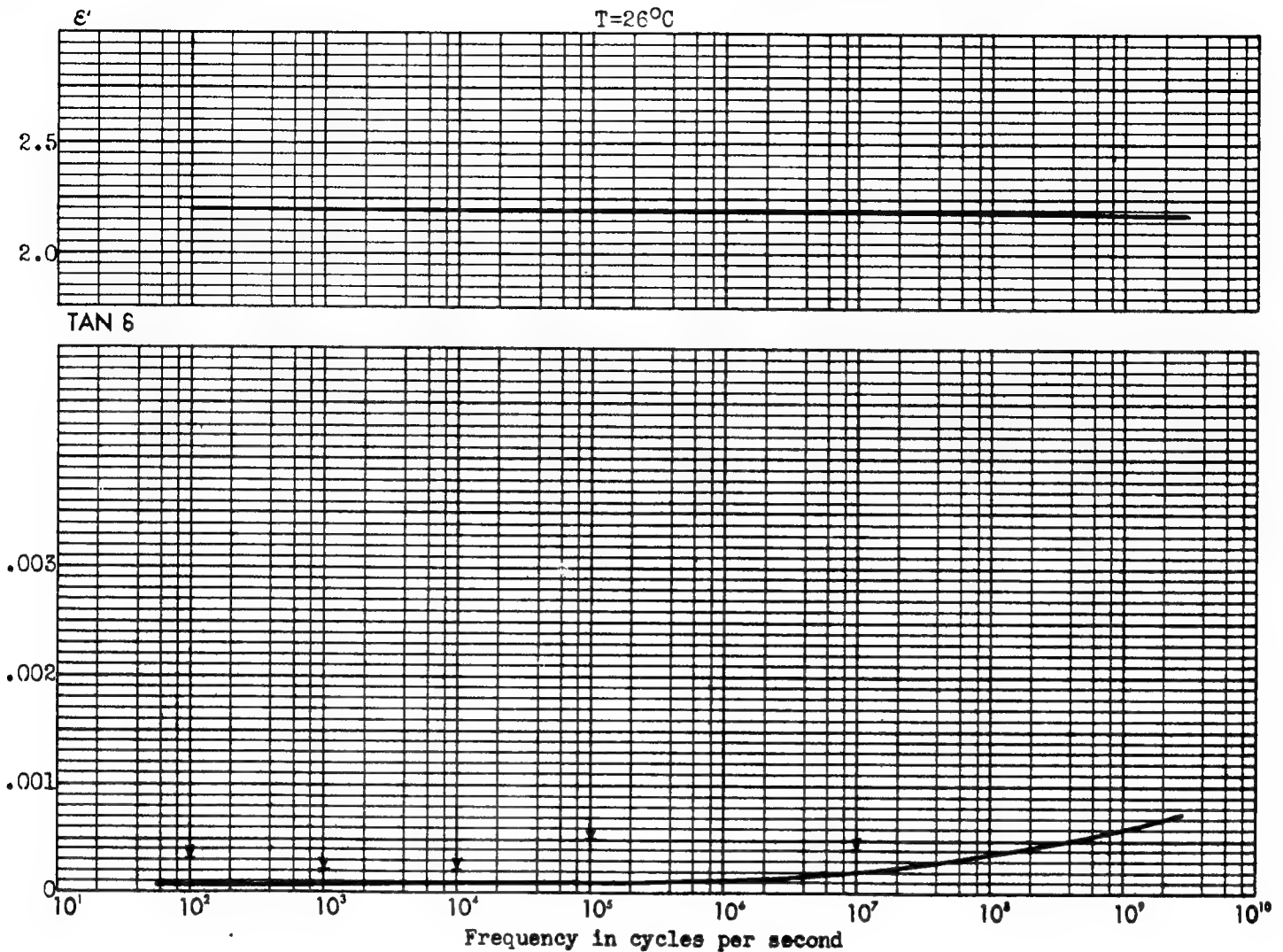
Availability: Commercial production under allocation.



Chemical Name: Vinyl benzene

Composition: Styrene purified by fractional distillation in vacuo.

Properties: See data on Styrene Monomer N-100 (unpurified).



Composition: Mixed petroleum hydrocarbons.

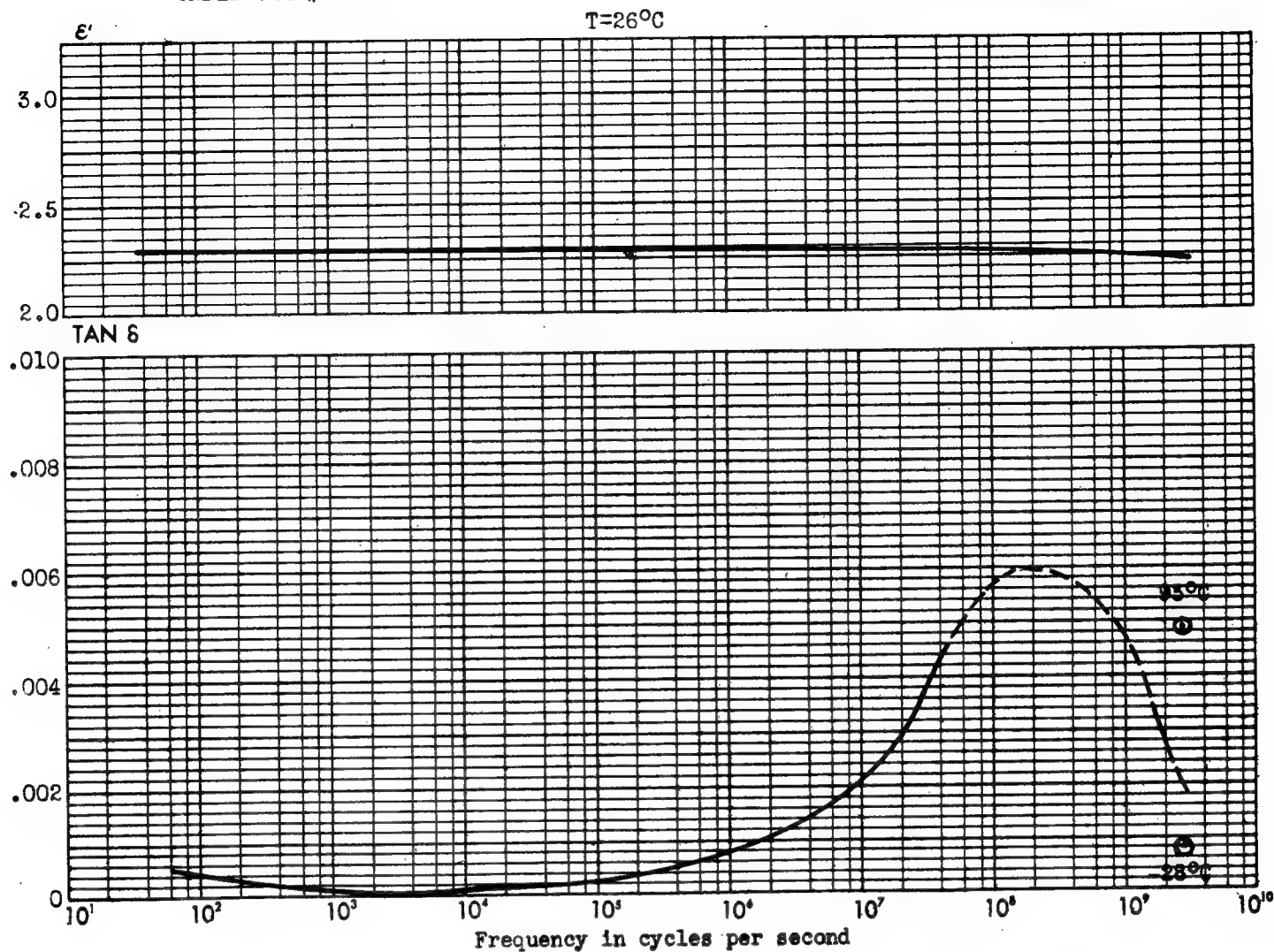
Properties: Colorless, clear and transparent.  $d^{15.6}_4 = 0.870-0.880$ . Pour Point  $<-15^\circ\text{C}$ .  
 B. P.  $276-404^\circ\text{C}$ . Flash P.  $182^\circ\text{C}$ . Fire P.  $210^\circ\text{C}$ . Spec. Heat 0.45 at  $50^\circ\text{C}$ .  
 Therm. Exp.  $7.06 \times 10^{-4}$ . Therm. Sta.: no change up to 48 hrs. at  $100^\circ\text{C}$ .  $n_D = 1.4801$ .  
 Visc.(cs.) 44.3,  $37.8^\circ\text{C}$ ; 31.5,  $54.5^\circ\text{C}$ ; 5.97,  $100^\circ\text{C}$ . Surf. Tens. 33,  $25^\circ\text{C}$ .  
 Chem. Res.: acids, excellent; alkalies, excellent; water, excellent; oxygen, excellent;  
 other reagents, excellent for most. Moist. Abs.: slight. Sun.: slight oxidation.  
 Sol.: soluble in naphtha, benzene and ether. Poly.: nil. Elec. Str. 500.

Precautions in Handling: Tox.: nil. Flam.  $>200^\circ\text{C}$ .

Recommended Uses: High frequency, high temperature liquid insulator.

Availability: Available in production quantity. Not under allocation.



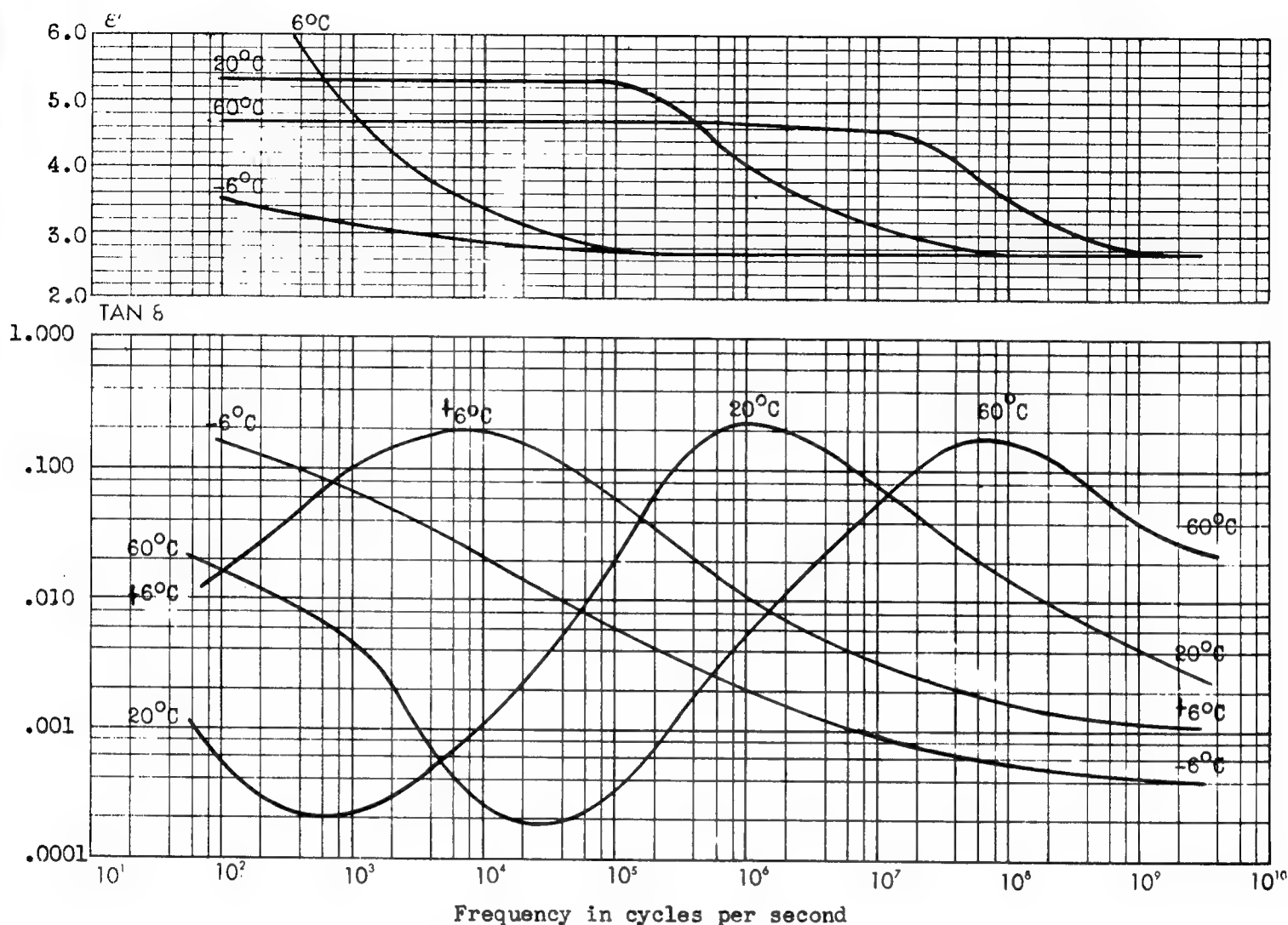


Properties: Very pale amber, clear.  $d_{15.5}^{15.5}=0.890$ . Pour Point  $-40^{\circ}\text{C}$  or lower.  
Flash P.  $155^{\circ}\text{C}$ . Fire P.  $185^{\circ}\text{C}$ . Spec. Heat:  $30-35^{\circ}\text{C}$ , 0.415.  $n_D=1.4950$ .  
Visc.(sec.):  $37.8^{\circ}\text{C}$ , 100;  $100.0^{\circ}\text{C}$ , 37.

Recommended Uses: Filler for dielectric cables.

Availability: Commercial quantities.





Composition: Mixture of pentachlorodiphenyl and trichlorobenzene.

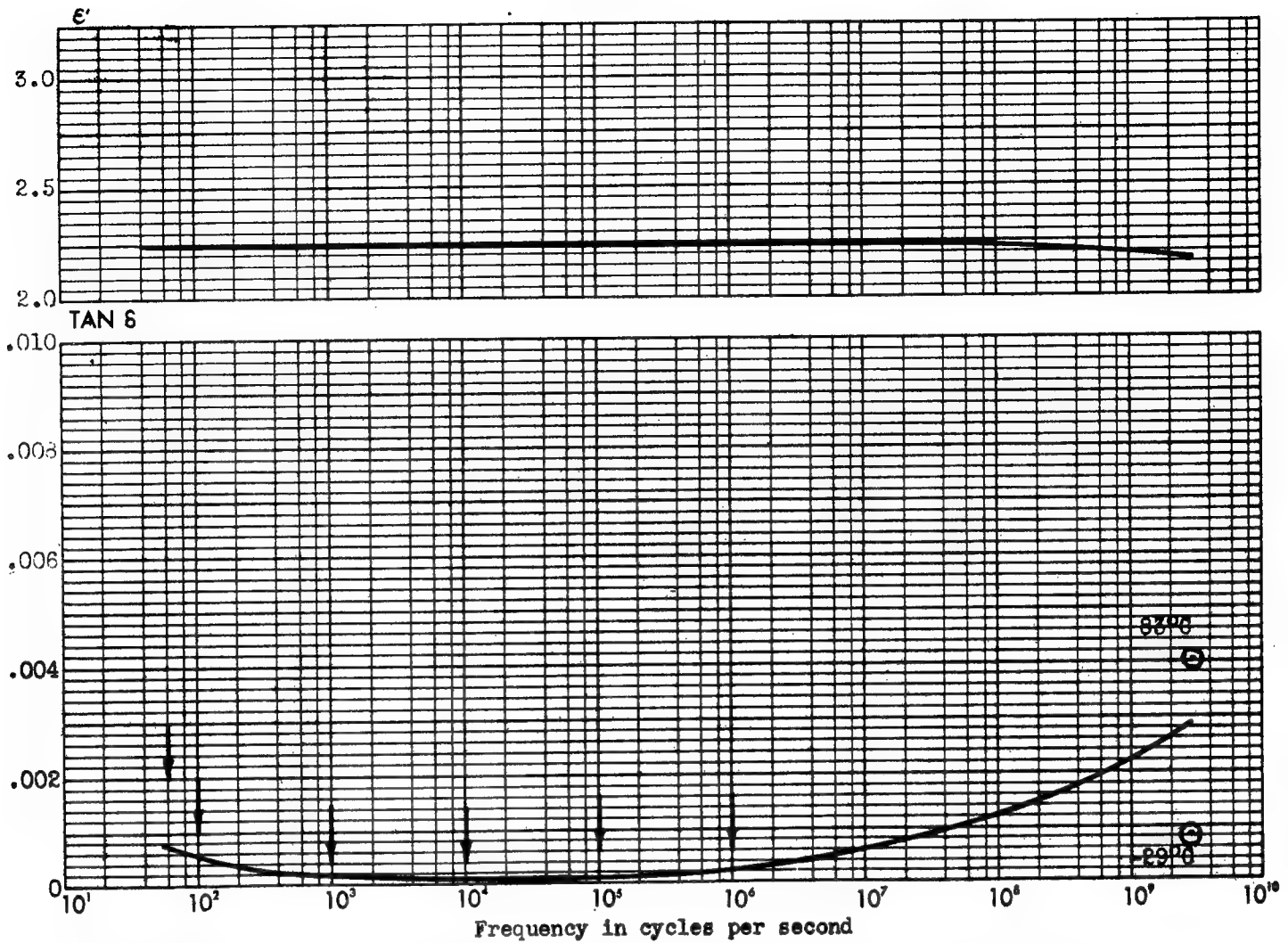
Properties: Clear, straw yellow.  $d_{15.5}^{65}=1.500$ . Pour Point  $10^{\circ}\text{C}$ . B. P.  $350-375^{\circ}\text{C}$ .  
 Spec. Heat:  $30-35^{\circ}\text{C}$ , 0.262. Flam.: none.  $n_D=1.6380$ . Visc.(sec.):  $37.8^{\circ}\text{C}$ , 2000;  
 $100.0^{\circ}\text{C}$ , 46.

Precautions in Handling: Tox.: slight

Recommended Uses: Capacitor oil, transformer oil.

Availability: Commercial quantities.

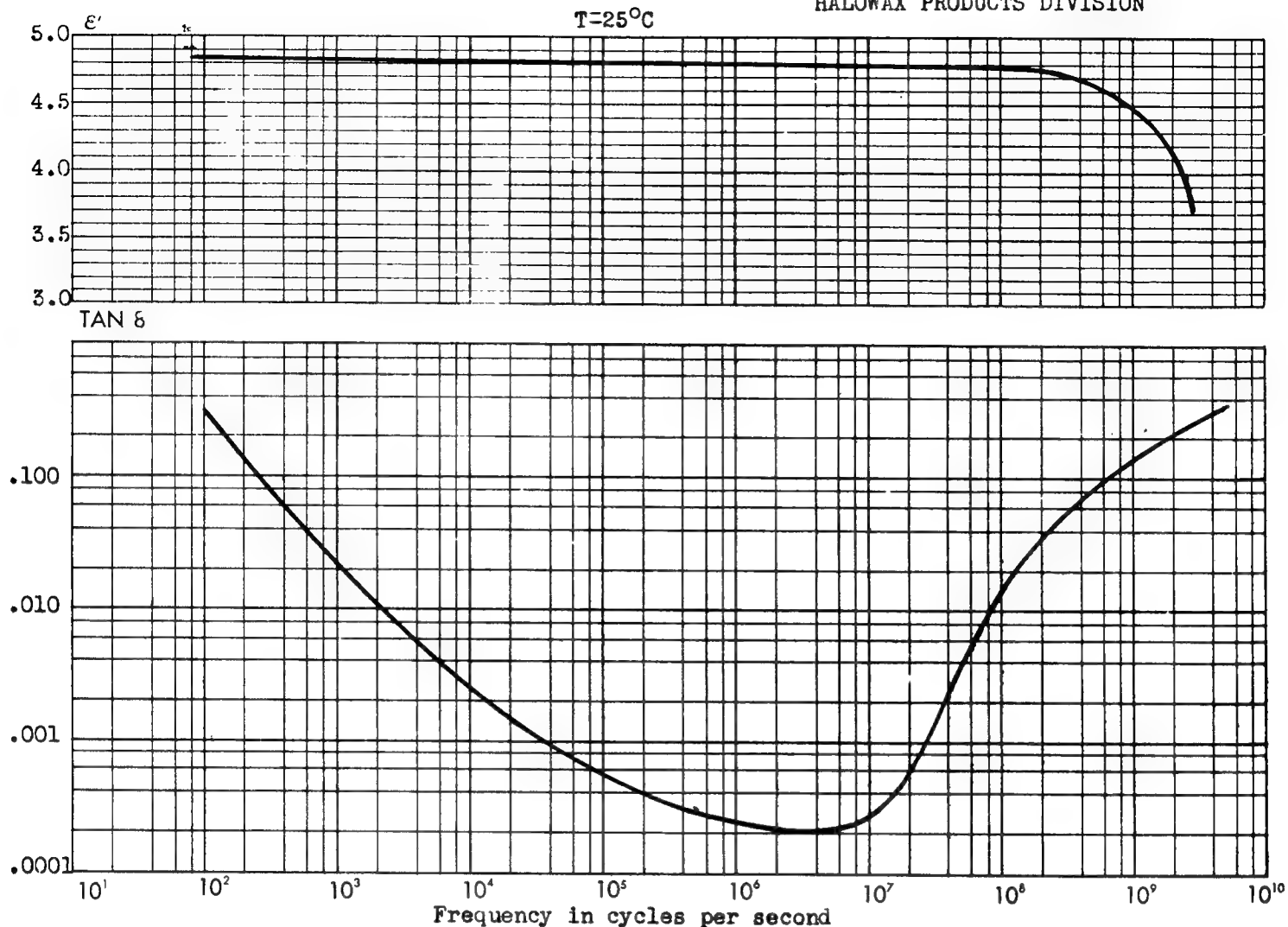
T=26°C



Properties: Very pale amber, clear.  $d_{15.5}^{15.5}=0.880$  Pour Point  $-40^{\circ}\text{C}$  or lower.  
B. P.  $250-400^{\circ}\text{C}$ . Flash P.  $135^{\circ}\text{C}$ . Fire P.  $148^{\circ}\text{C}$ . Spec. Heat:  $30-35^{\circ}\text{C}$ , 0.425.  
 $n_D=1.4830$ . Visc.(sec.)  $37.8^{\circ}\text{C}$ , 58.

Recommended Uses: Transformer oil.

Availability: Commercial quantities.



Chemical Name: Chlorinated naphthalene

Composition: Chlorinated naphthalene containing approximately 25% chlorine.

Properties: Water white.  $d_{25}^{25}=1.19-1.25$ . M. P.  $-38^{\circ}\text{C}$ . B. P.  $249-282^{\circ}\text{C}$ .

Flash P.  $95^{\circ}\text{C}$ . Fire P.  $170^{\circ}\text{C}$ . Spec. Heat  $0.282$   $27^{\circ}\text{C}$  and  $63^{\circ}\text{C}$ .

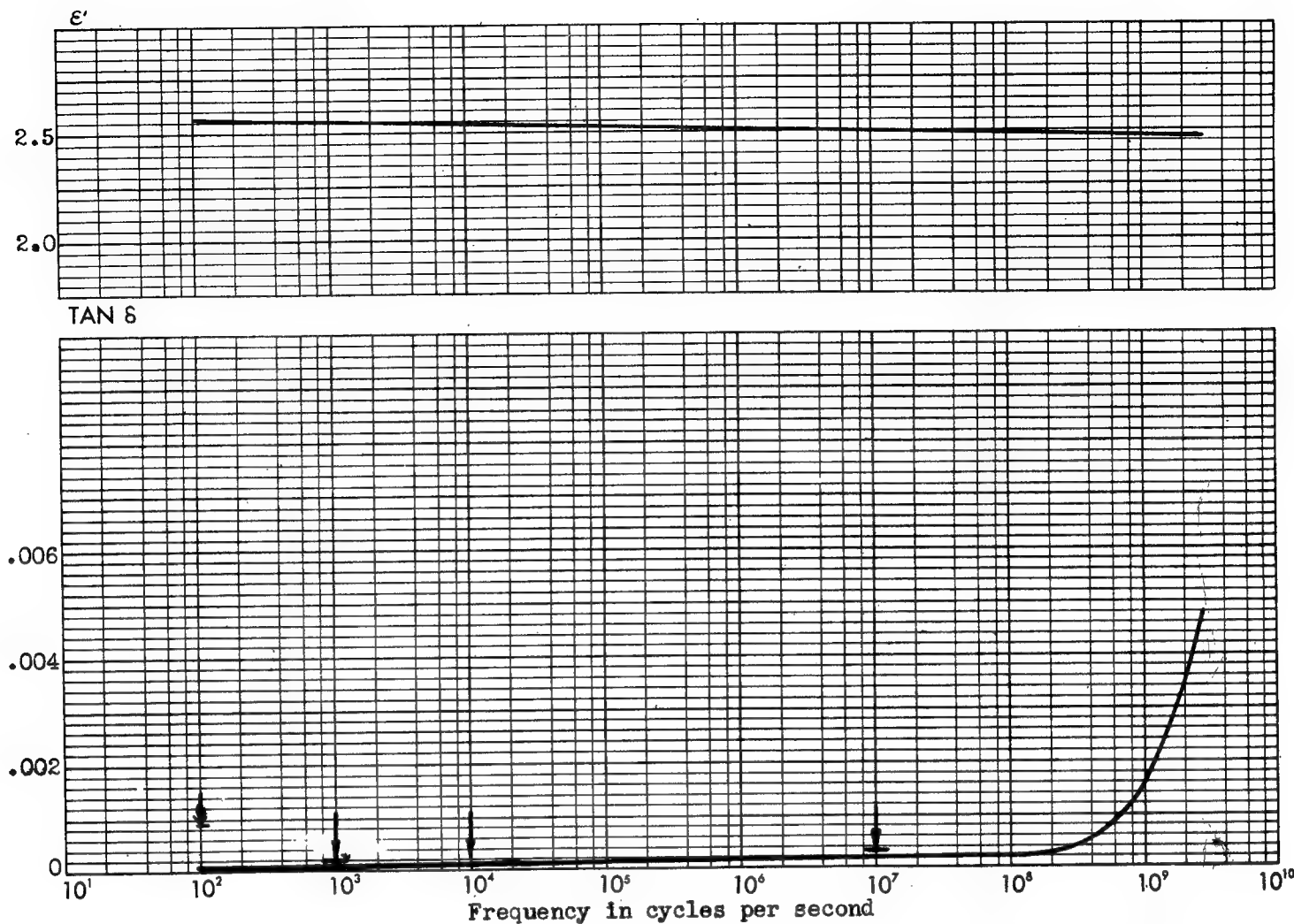
Therm. Exp.  $2.1 \times 10^{-4}$ .  $n_D=1.6335$ . Visc.(sec.) 33-37,  $25^{\circ}\text{C}$ . Sun.: darkens.

Sol.: soluble in common hydrocarbon solvents.

Precautions in Handling: Tox.: continuous contact to be avoided. Inflammable.

Recommended Uses: Petroleum additive; index of refraction standard.

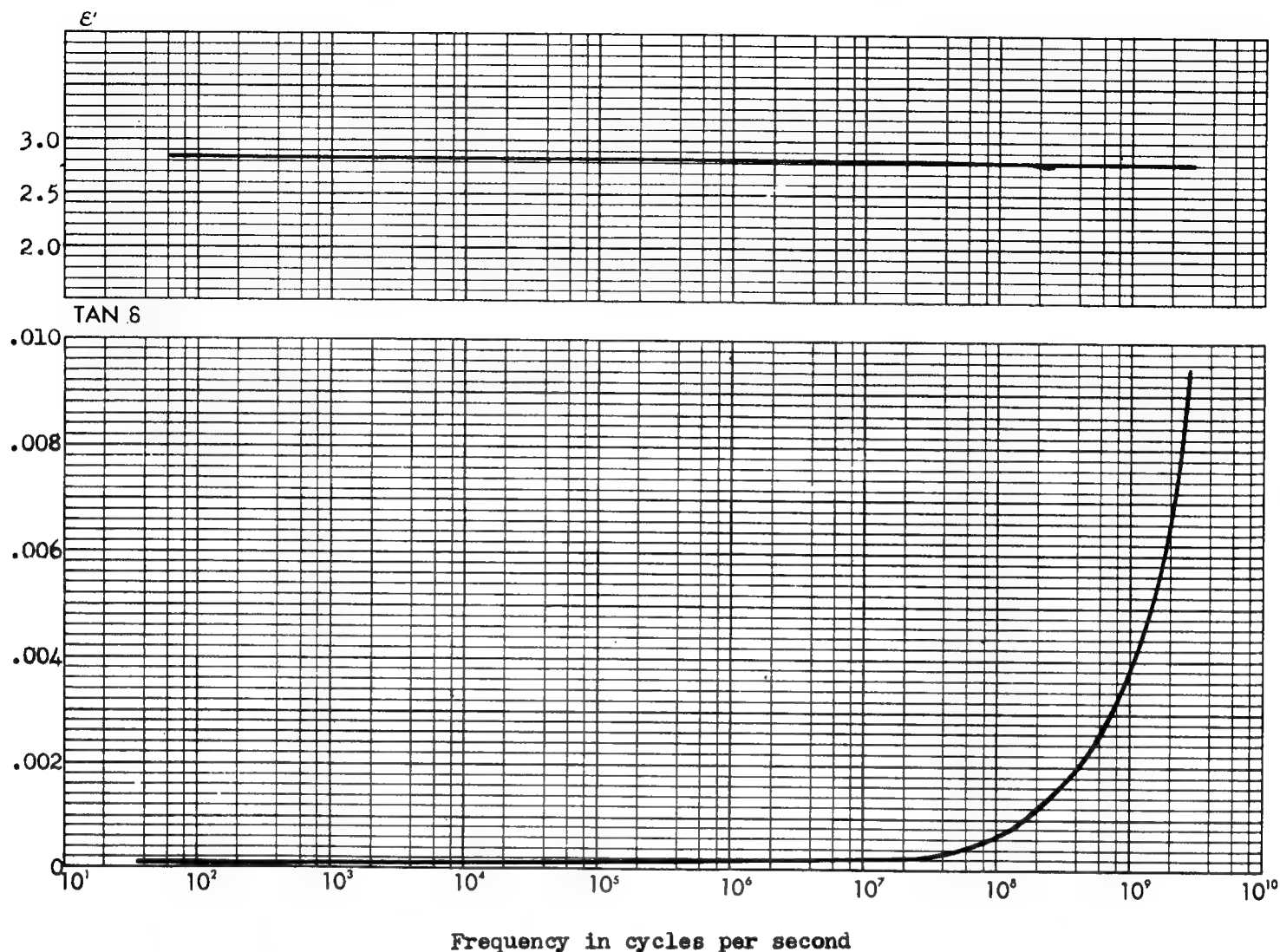
Availability: Commercial quantities.



Properties: Water white liquid.  $d_{25}^{25}=0.9559$ . M. P.  $-44^{\circ}\text{C}$ . B. P.  $205^{\circ}\text{C}$  at 750 mm.  
Vapor Pressure: 100 mm. at  $140^{\circ}\text{C}$ ; 20 mm. at  $100^{\circ}\text{C}$ . Flash P.  $25^{\circ}\text{C}$ . Flam.: high.  
Therm. Exp.  $1.244 \times 10^{-5}$ .  $n_D^{25}=1.3958$ . Visc.(cs.) 3.78 at  $25^{\circ}\text{C}$ ; 24.50 at  $-40^{\circ}\text{C}$ .  
Chem. Res.: dilute acids, good; alkalies, fair; water, excellent; oxygen, excellent.  
Sun.: none. Poly.: slight.

Precautions in Handling: Tox.: relatively inert physiologically.

Availability: Development scale quantities.



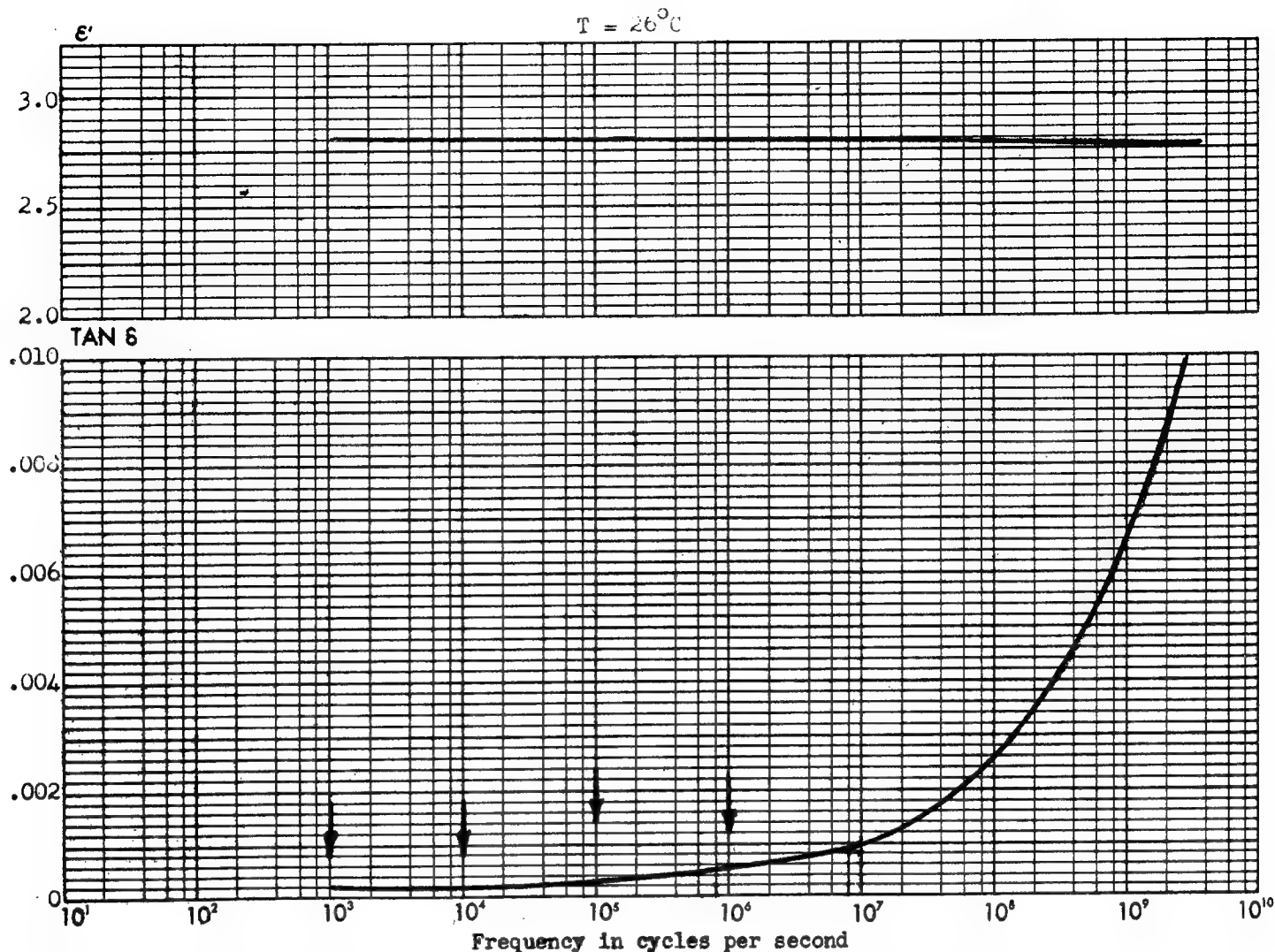
**Properties:** Water white liquid.  $d_{25}^{25}=0.971$ . Solidification P.  $-40^{\circ}\text{C}$ . Vapor Pressure:  $<10$  mm. at  $250^{\circ}\text{C}$ . Flash P.  $330^{\circ}\text{C}$ . Spec. Heat: 0.30 at  $0^{\circ}\text{C}$ ; 0.512 at  $25^{\circ}\text{C}$ ; 0.352 at  $100^{\circ}\text{C}$ . Therm. Exp.  $0.968 \times 10^{-3}$ . Therm. Sta.: no more than 5% increase in viscosity in 96 hrs. at  $160^{\circ}\text{C}$ .  $n_D^{25}=1.4031$ . Visc.(cs.) 200 at  $25^{\circ}\text{C}$ ; 1300 at  $-40^{\circ}\text{C}$ . Surf. Tens. 19.9. Chem. Res.: dilute acids, good; alkalies, fair; water, excellent; oxygen, excellent; chlorine gas, excellent. Moist. Abs.  $<0.1\%$ . Flam.: low. Sol.: insoluble in alcohols; soluble in aromatic hydrocarbons. Poly.: slight.

**Precautions in Handling:** Do not rub eyes with hands that have handled oil. Eyes will smart but effect will wear off in a few hours.

**Recommended Uses:** Damping fluid; insulating liquid for quartz crystals in supersonic vibrators.

**Availability:** In large scale production. Regularly furnished in the following viscosity types at  $25^{\circ}\text{C}$ : 100 cs., 200 cs., 350 cs., 500 cs. and 1000 cs.

**NOTE:** The oil having viscosity of 200 cs. is typical of the Type 200 Dow Corning Fluids and is the one whose properties are given above.

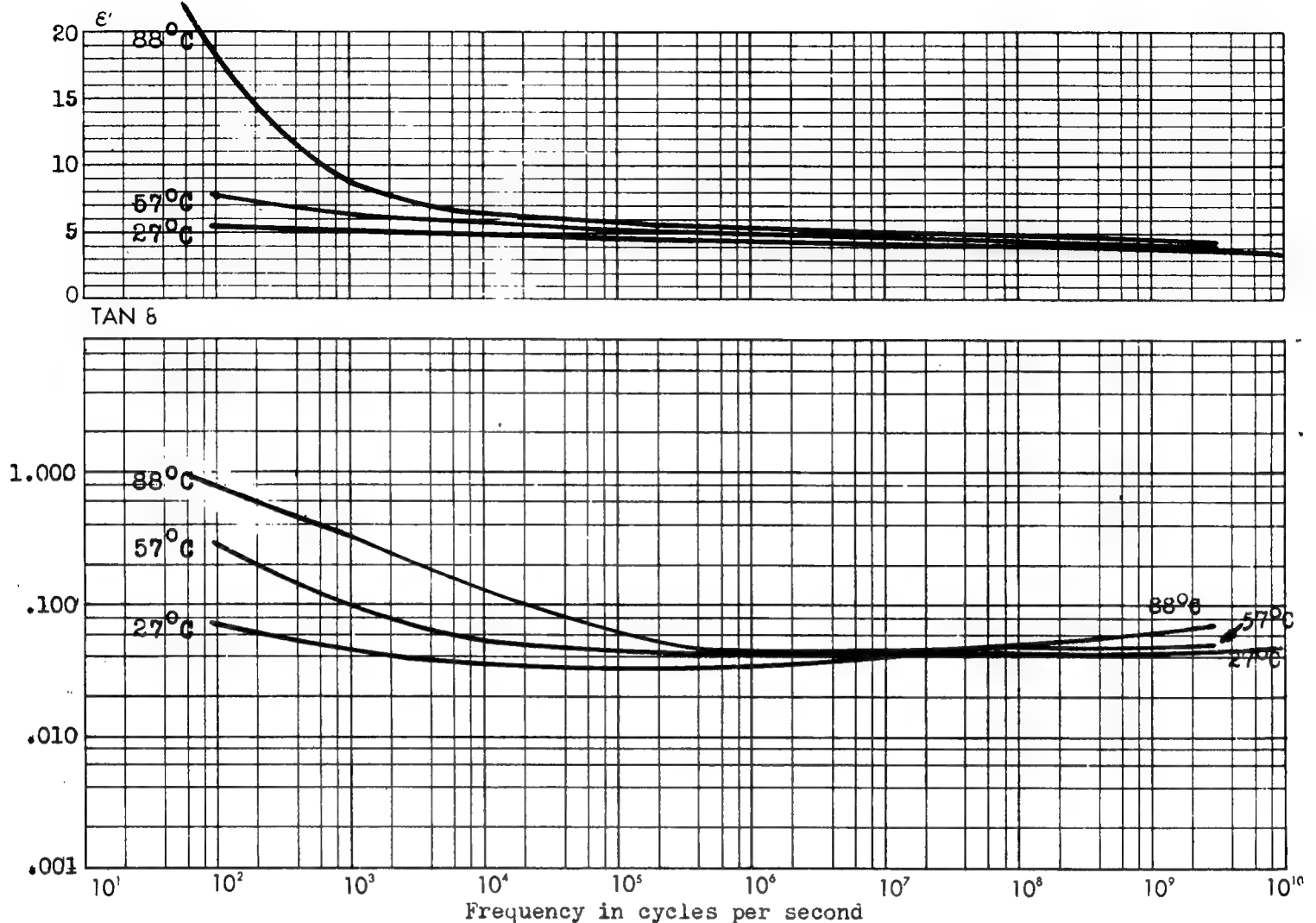


**Properties:** Colorless, vaseline-like grease.  $d_{25}^{25} = 0.98-1.00$ . M. P.: does not harden at  $-40^{\circ}\text{C}$  to  $204^{\circ}\text{C}$ . Penetration 30. Vapor Pressure:  $25^{\circ}\text{C}$ , nil. Flash P.  $>330^{\circ}\text{C}$ . Flam.: burns. Therm. Exp.  $63 \times 10^{-5}$ . Therm. Sta.  $>230^{\circ}\text{C}$ . Chem. Res.: oils, anti-freeze liquids and water, excellent; gasoline, benzene and carbon tetrachloride, poor. No effect on rubber, neoprene and ethyl cellulose 100 hrs. at  $150^{\circ}\text{C}$ . Elec. Str. 500 for .01" gap. Vol. Res.:  $1 \times 10^{-13}$  at  $21^{\circ}\text{C}$ ;  $1 \times 10^{-12}$  at  $204^{\circ}\text{C}$ . Arc Res. 80.

**Precaution in Handling:** Do not rub eyes with hands after using.

**Recommended Uses:** Lubricant for aircraft ignition harnesses. Moisture seal in aircraft ignition cable junctions. Moisture proof seal in radio and radar connectors.

**Availability:** Available in consistencies ranging from light petroleum jelly to heavy extremely stiff grease. Supplied in tubes, cans or drums under allocation.



Chemical Name: Phenol-formaldehyde resin.

Composition: Cross-linked condensation polymer of phenol and formaldehyde (45-46% by weight), filler (46% by weight) and miscellaneous (ca. 8%).

Properties: (Based on compression molded specimens). Black.  $d^{25}=1.32-1.37$ . Ten. Str. 7000-8500. Rockwell M115-M120. Imp.(Izod) 25°C 0.28-0.32. Mod. El.: in flexure 25°C  $0.8-1.1 \times 10^6$ . Comp. Str. 25,000-30,000. Flex. Str. 25°C 9000-11,000. Elong. >1% (at breaking load 25°C). Mach.: good. Spec. Heat 0.25-0.40. Therm. Exp.  $30-40 \times 10^{-6}$ . Therm. Cond.  $4-7 \times 10^{-4}$ .  $T_{dis} < 135^\circ\text{C}$ . Thermosetting. Chem. Res.(22.2°C): organic acids, excellent; strong mineral acids, fair to good; oxidizing acids, poor; weak mineral acids, good; alkalis, poor; solvents, good; water, good; oxygen, good against dry gas at 22.2°C. Sun.: slight dulling of surface and related color change. Moist. Abs. <0.6%. Flam.: slow burning. Elec. Str.: short time 300-350 (1/8" thick); step-by-step 275-325 (1/8" thick).

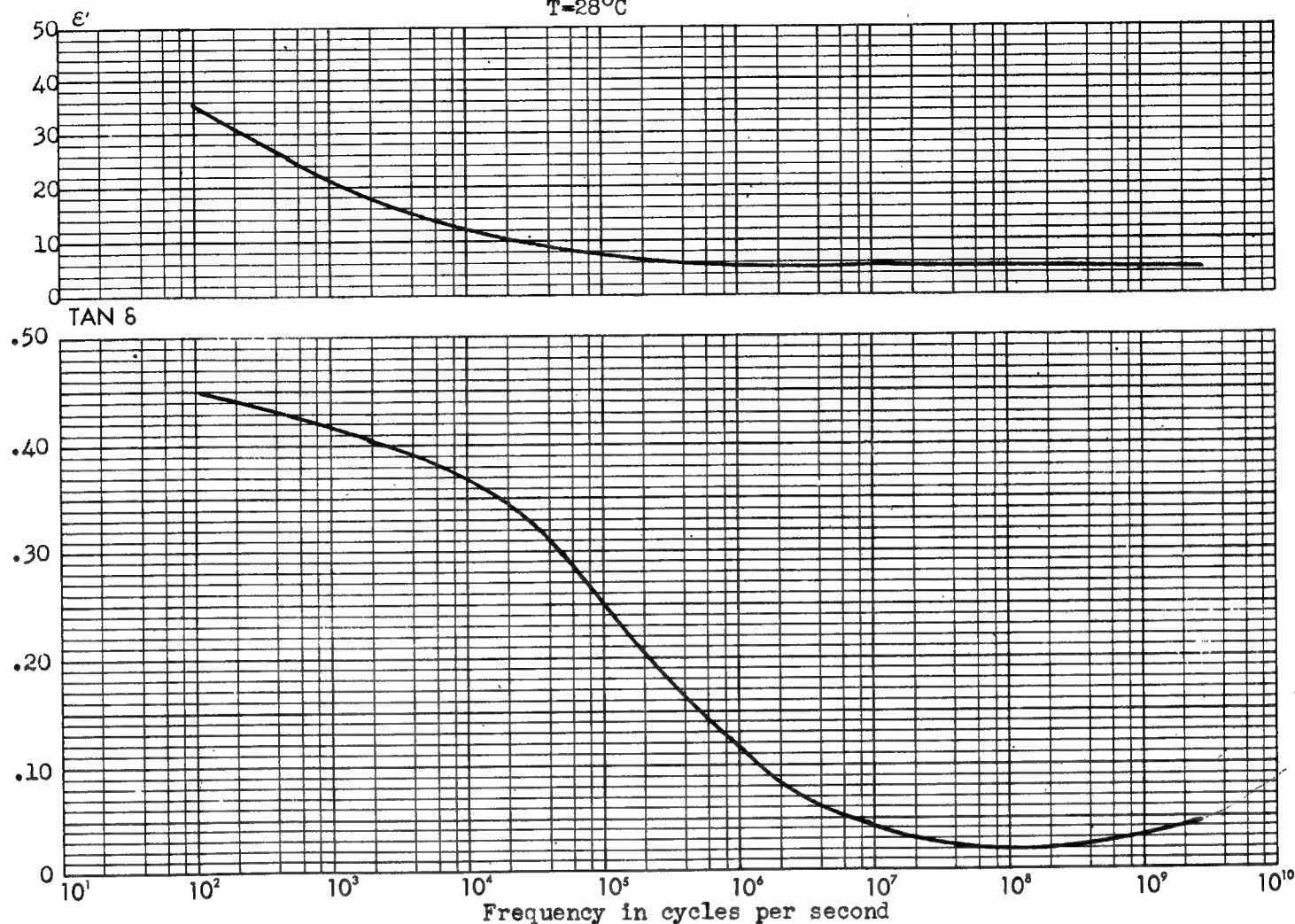
Methods of Handling: Compr. Mold. 149-168°C, 2000-5000; Transfer Mold. 149-168°C, 5000-12,000.

Recommended Uses: General purpose molding material having a wide range of applications and capable of being molded under a wide variety of conditions into parts having a clean, lustrous finish.

Availability: Dry granular powder in production quantities.



T=28°C



Chemical Name: Phenol-formaldehyde resin. Sample Designation: Batch 113A

Composition: Cross-linked condensation polymer of phenol and formaldehyde (34% by weight) with filler (66% by weight).

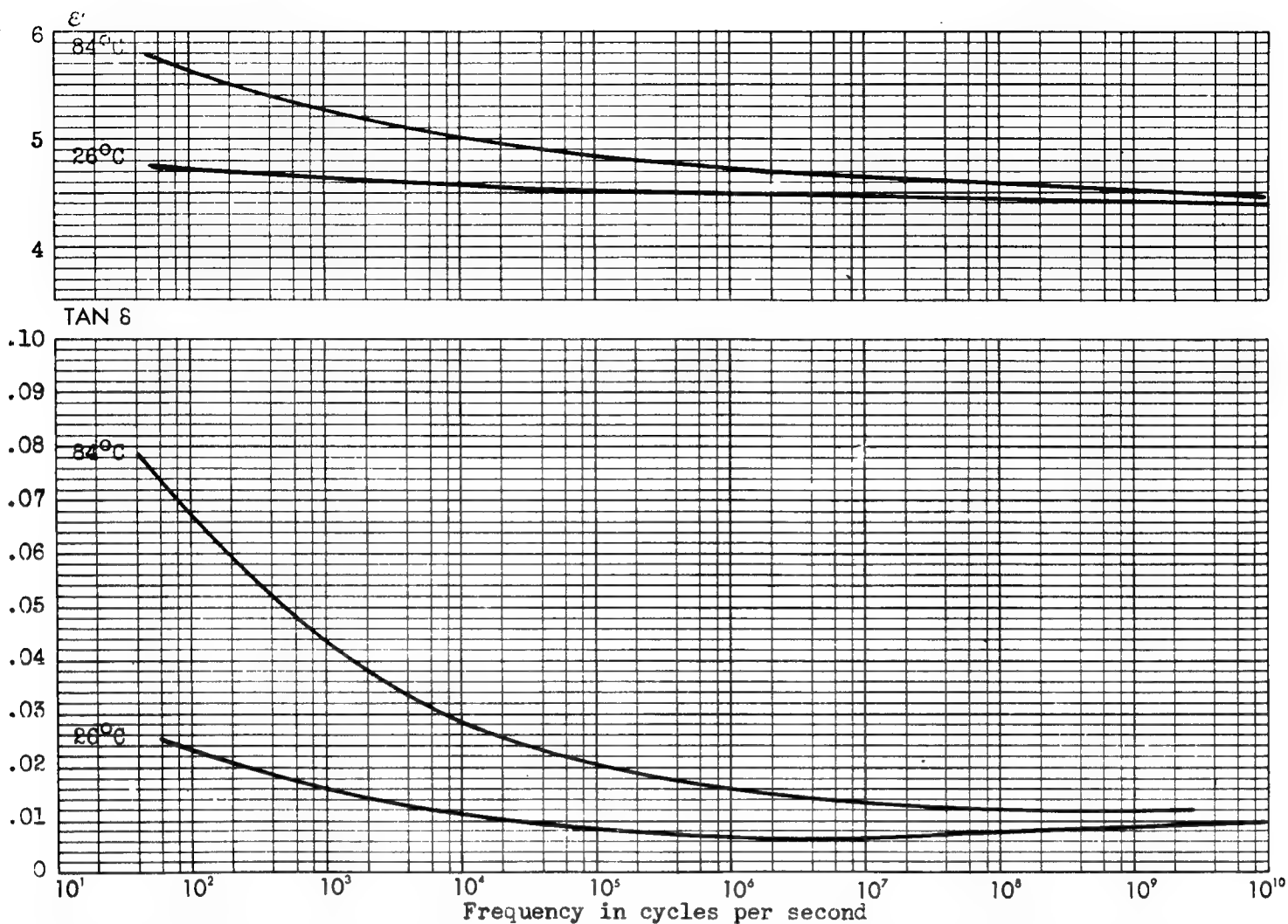
Properties: (Based on compression molded specimens). Opaque, dark brown.  $d^{25}_D = 1.85-1.95$ . Ten. Str. 4500-6000. Rockwell M110-M120. Imp.(Izod) 25°C 0.65-0.80. Mod. El.: in flexure 25°C  $1.4-2.0 \times 10^6$ . Comp. Str. 15,000-30,000. Flex. Str. 25°C, 10,000-12,000. Elong.: at breaking load 1% 25°C. Mach.: fair. Spec. Heat 0.28-0.32. Therm. Exp.  $15-25 \times 10^{-6}$ . Therm. Cond.  $8-16 \times 10^{-4}$ .  $T_{dis}$  145°C. Thermosetting. Chem. Res.(22.2°C): weak mineral acids, good; strong mineral acids, fair to good; organic acids, excellent; oxidizing acids, poor; alkalies, poor; solvents, good; water, excellent; oxygen, good against dry gas at 22.2°C. Sun.: slight dulling of surface and related color change. Moist. Abs. 0.3%. Flam.: slow burning. Elec. Str.: short time 200-250 (1/8" thick); step-by-step 175-225 (1/8" thick).

Methods of Handling: Compr. Mold. 132-154°C, 3000-5000; Transfer Mold. 132-149°C, 10,000.

Recommended Uses: For parts requiring heat and water resistance with improved impact strength such as molded commutators, connector plugs, etc., and parts subjected to stresses at elevated temperatures.

Availability: Dry fluffy fibrous powder in production quantities.





**Chemical Name:** Phenol, aniline, formaldehyde resin. **Sample Designation:** Batch 655 A.

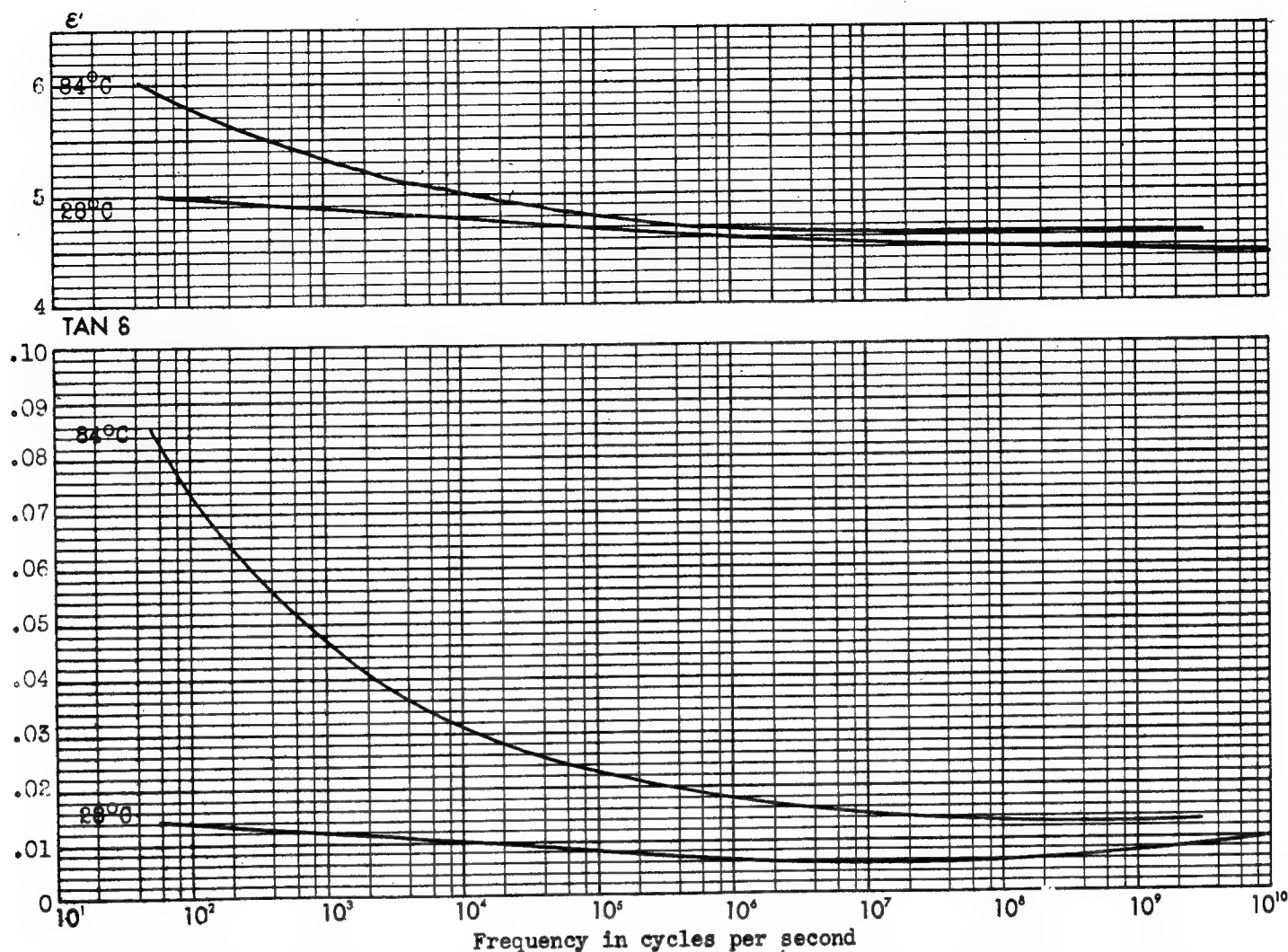
**Composition:** Cross-linked condensation polymer of phenol and aniline with formaldehyde (38% by weight) with filler (62% by weight).

**Properties:** (Based on compression molded specimens). Opaque, tan.  $d_{25}^{25}=1.87-1.93$ . **Ten. Str.** 4500-6000. **Rockwell M90-M110**. **Imp.(Izod)** 25°C 0.30-0.36. **Mod. El.:** in flexure  $2.5-4.0 \times 10^6$ . **Comp. Str.** 14,000-20,000. **Flex. Str.** 25°C 8000-10,000. **Elong.:** at breaking load 1% 25°C. **Mach.:** poor. **Spec. Heat** 0.28-0.32. **Therm. Exp.**  $10-20 \times 10^{-6}$ . **Therm. Cond.**  $10-14 \times 10^{-4}$ .  $T_{dis}$  100-115°C. **Therm. Sta.** 66°C. **Thermosetting.** **Chem. Res. (22.2°C):** weak mineral acids, good; strong mineral acids, fair to good; organic acids, excellent; oxidizing acids, poor; alkalies, poor; solvents, good; water, excellent; oxygen, excellent against dry gas at 22.2°C. **Sun.:** slight dulling of surface and related color change. **Moist. Abs.** 0.3%. **Flam.:** slow burning. **Elec. Str.:** short time 325-375 (1/8" thick); step-by-step 300-350 (1/8" thick).

**Methods of Handling:** Compr. Mold. 132-160°C, 3000-5000; Transfer Mold. 132-154°C, 10,000.

**Recommended Uses:** For radio insulation where low water absorption is desired.

**Availability:** Dry granular powder in production quantities.



Chemical Name: Phenol, aniline, formaldehyde resin. Sample Designation: Batch 40A

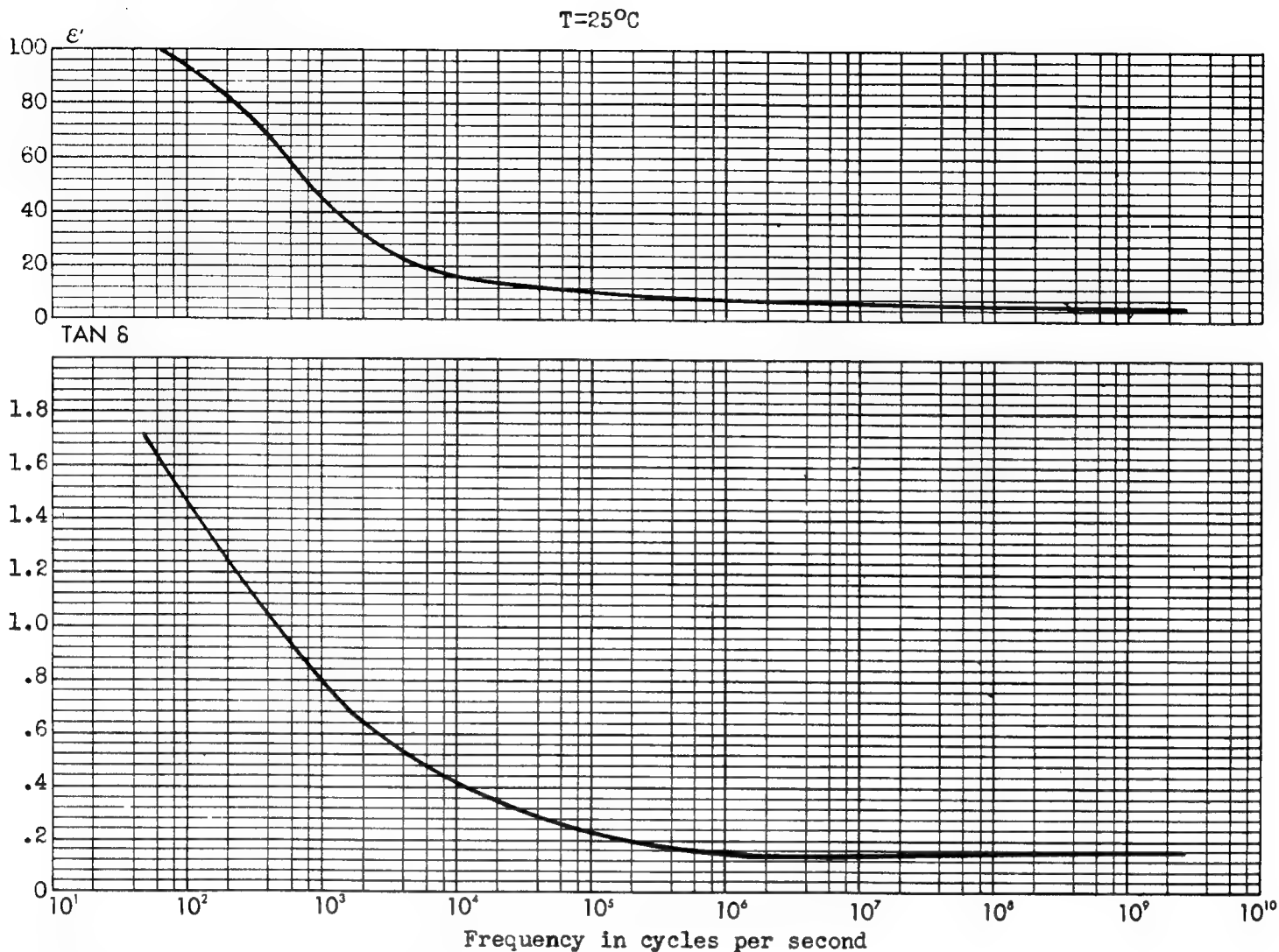
Composition: Cross-linked condensation polymer of phenol and aniline with formaldehyde (32% by weight) with filler (59½% by weight) and miscellaneous (ca. 8½% by weight).

Properties: (Based on compression molded specimens). Opaque, black.  $d_{25}^{25}=1.85-1.92$ . Ten. Str. 4500-6000. Rockwell M90-M110. Imp.(Izod) 0.30-0.36 25°C. Mod. El.: in flexure  $2.5-4.0 \times 10^6$ , 25°C. Comp. Str. 25°C 14,000-20,000. Flex. Str. 25°C, 8000 to 10,000. Elong.: at breaking load  $<1\%$  25°C. Mach.: poor. Spec. Heat 0.28-0.32. Therm. Exp.  $10-20 \times 10^{-6}$ . Therm. Cond.  $10-14 \times 10^{-4}$ . Tdis 100-115°C. Therm. Sta. 66°C. Thermosetting. Chem. Res.(22.2°C): organic acids, excellent; strong mineral acids, fair to good; weak mineral acids, good; oxidizing acids, poor; alkalies, poor; solvents, good; water, good; oxygen, good against dry gas at 22.2°C. Sun.: slight dulling of surface and related color change. Moist. Abs.  $<0.3\%$ . Flam.: slow burning. Elec. Str.: short time 325-375 (1/8" thick); step-by-step 300-350 (1/8" thick).

Methods of Handling: Compr. Mold. 132-160°C, 300-5000; Transfer Mold. 132-160°C, 10,000.

Recommended Uses: Material for radio insulation. Useful where low loss factor or exceptional electrical properties are desired.

Availability: Dry granular powder in production quantities.



Chemical Name: Phenol-formaldehyde resin

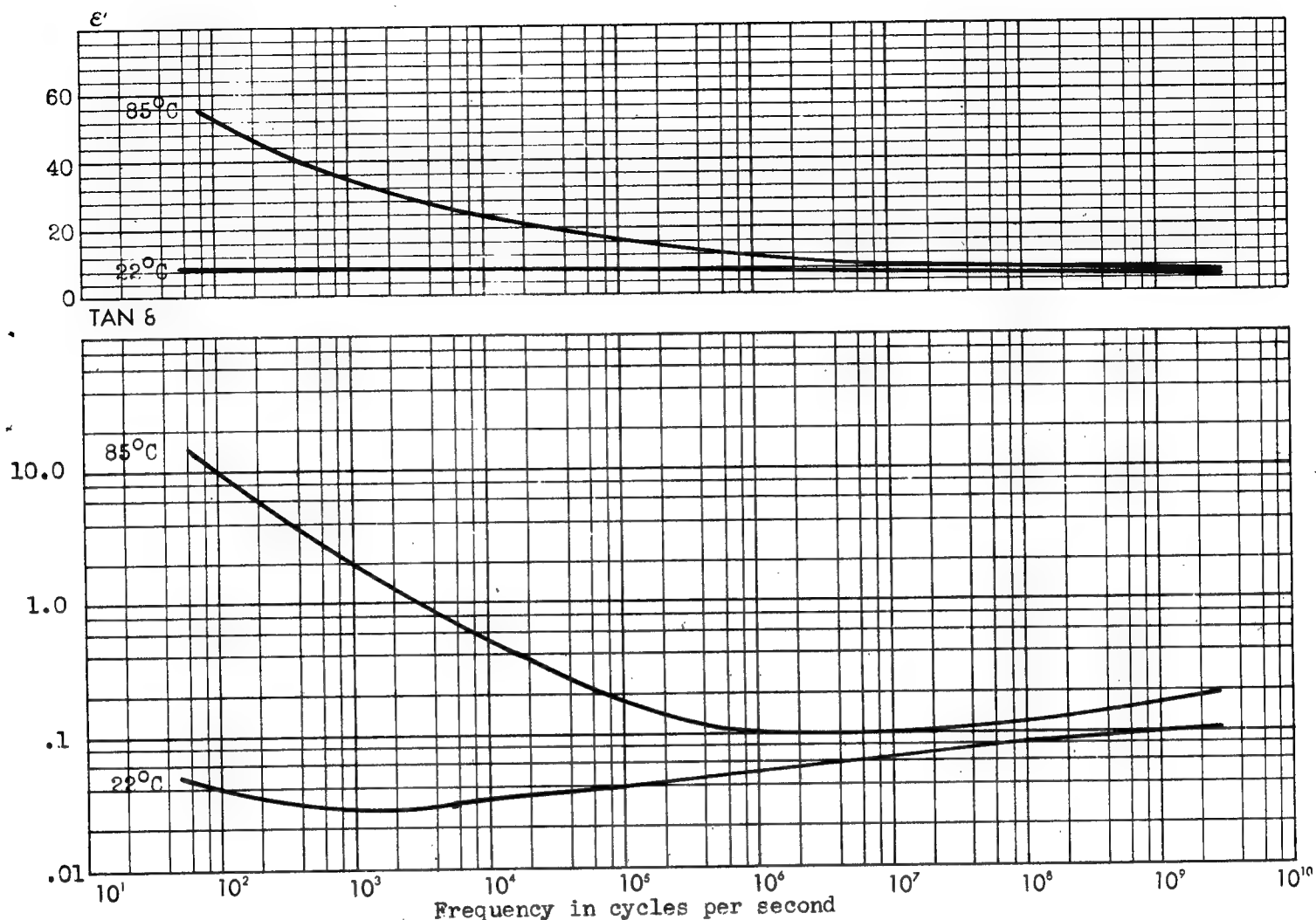
Composition: Cross-linked condensation polymer of phenol and formaldehyde (100%).

Properties: Clear, colorless.  $d_{25}^{25}=1.30-1.335$ . Ten. Str. 3000-3500. Rockwell M30-M40. Imp.(Izod)  $25^{\circ}\text{C}$  0.45. Mod. El.: in tension  $1.25-4 \times 10^5$ . Comp. Str. 4000-7000. Shear. Str.: 1" dia. plunger 3000-4000. Flex. Str.  $25^{\circ}\text{C}$  2950. Mach.: excellent. Therm. Exp.  $8.3-13 \times 10^{-5}$ .  $T_{dis}$   $35-45^{\circ}\text{C}$ . Thermosetting. Chem. Res.: acids, fair to good; alkalis, poor; solvents, fair; water, fair. Sun.: yellows. Flam.: will not support combustion. Elec. Str. 76-98.  $n_D=1.59-1.62$ .

Methods of Handling: Casting and machining only.

Recommended Use: Fabrication of transparent objects.

Availability: Cylinders, rods, sheets, plates, etc. in plant production.



Chemical Name: Phenol-formaldehyde resin.

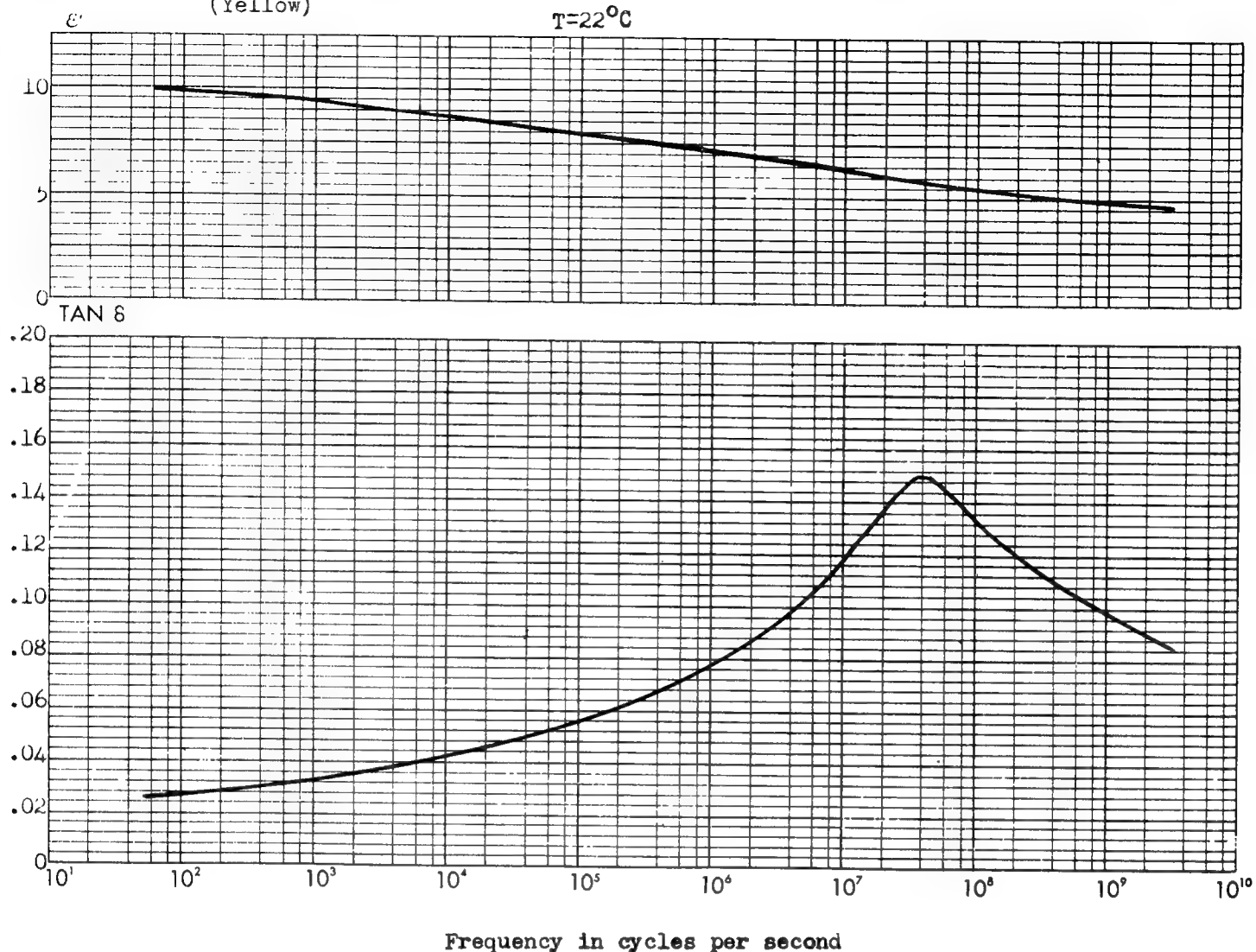
Composition: Cross-linked condensation polymer of phenol and formaldehyde (100%).

Properties: White, opaque.  $d_{25}^{25}=1.325$ . Ten. Str. 8000-9000. Rockwell M80-M85. Imp.(Izod) 25°C 0.30-0.40. Mod. El.  $3-6 \times 10^5$ . Comp. Str. 14,000-25,000. Shear. Str.: 1" dia. plunger 4000-6000. Flex. Str. 25°C 6600-9000. Mach.: excellent. Spec. Heat 0.3-0.4. Therm. Exp.  $7.5-15 \times 10^{-5}$ . Therm. Cond.  $3.5 \times 10^{-4}$ . Tdis 40-60°C. Thermosetting. Chem. Res.: acids, fair to good; alkalies, poor; solvents, fair; water, fair. Sun.: yellows. Flam.: will not support combustion. Elec. Str. 175-250.

Methods of Handling: Casting and machining only.

Recommended Use: Fabrication of an unlimited number of articles, often replacing metal.

Availability: Cylinders, rods, sheets, plates, etc. in plant production.



Chemical Name: Phenol-formaldehyde resin.

Composition: Cross-linked condensation polymer of phenol and formaldehyde (100%).

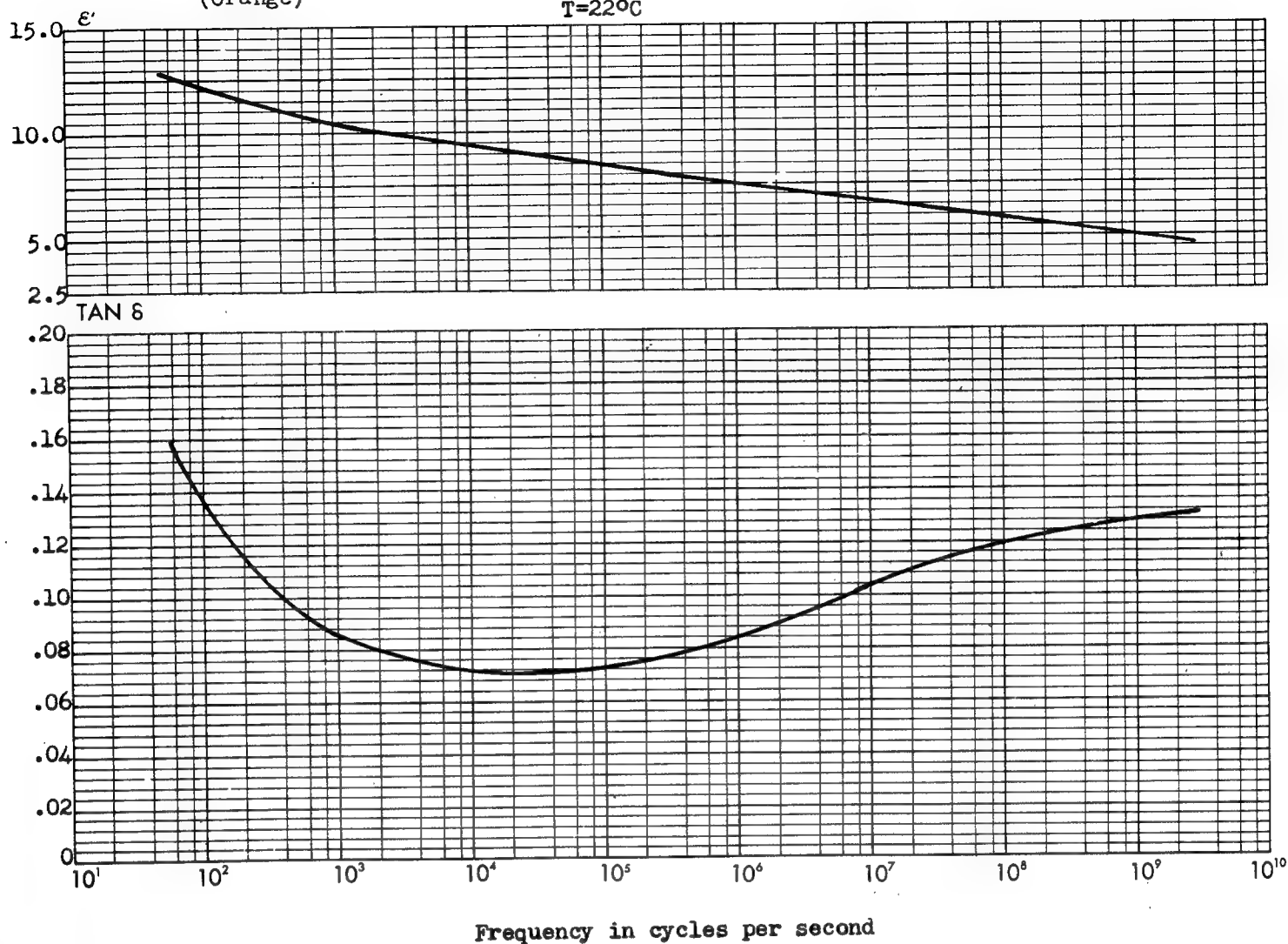
Properties: Yellow, opaque.  $d_{25}^{25}=1.32$ . Ten. Str. 8000-8500. Rockwell M40-M50. Imp.(Izod)  $25^{\circ}\text{C}$  0.4-0.5. Comp. Str. 18,000-20,000. Flex. Str.  $25^{\circ}\text{C}$  7500-10,000. Mach.: excellent. Spec. Heat 0.25-0.3. Therm. Exp.  $8-9 \times 10^{-5}$ .  $T_{\text{dis}}$   $52^{\circ}\text{C}$ . Thermosetting. Chem. Res.: acids, fair to good; alkalies, poor; solvents, fair; water, fair. Sun.: reddens. Flam.: very low; will not support combustion. Elec. Str. 150-210.

Methods of Handling: Casting and machining.

Recommended Uses: Fabrication of an unlimited number of products and articles, often replacing metals.

Availability: Cylinders, rods, sheets, plates, etc. in plant production.

T=22°C

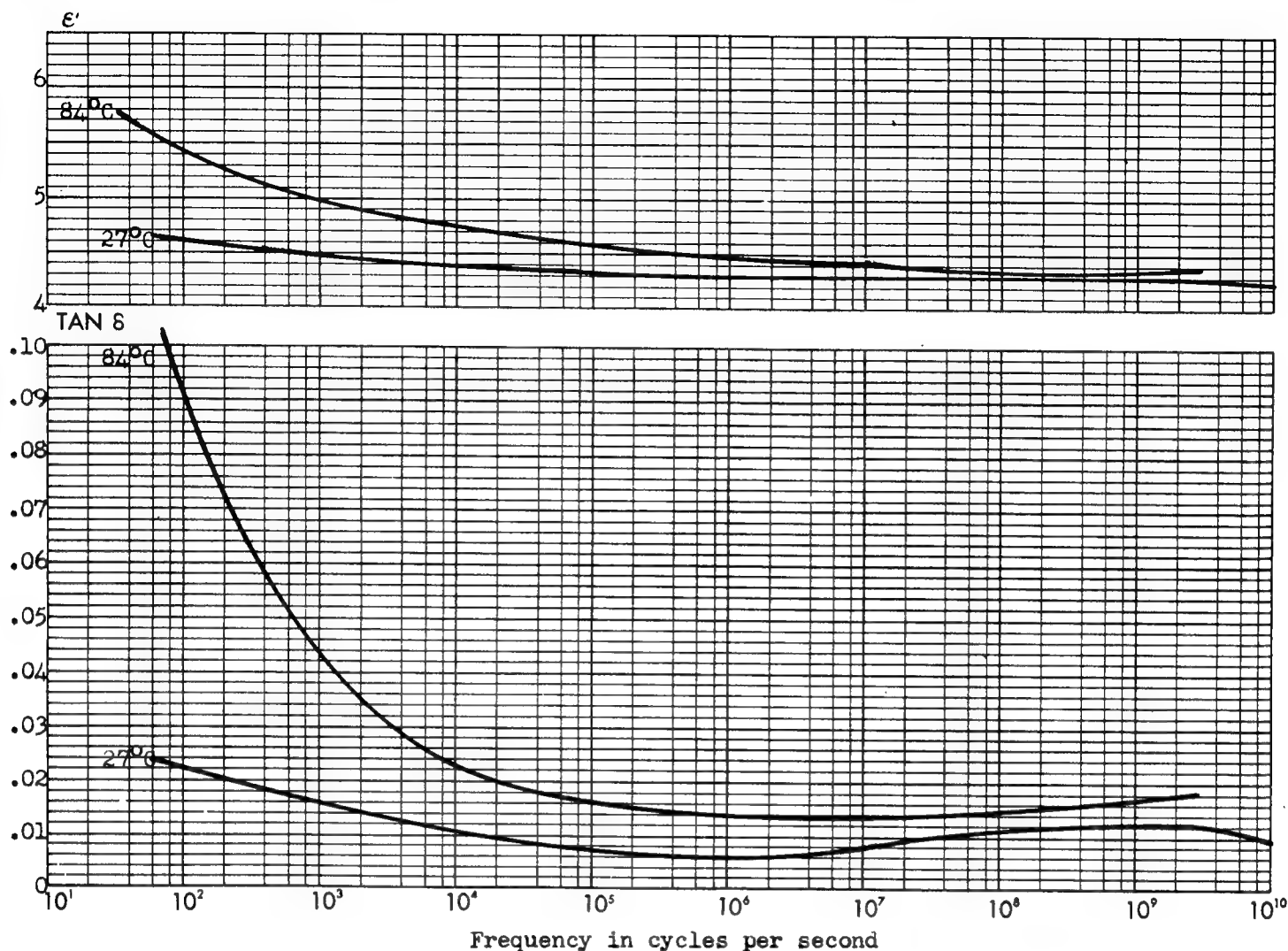


Chemical Name: Phenol-formaldehyde resin

Composition: Cross-linked condensation polymer of phenol and formaldehyde (100%).

Properties: Orange, opaque.

NOTE: For other properties see data on Catalin, 500 base (yellow).



Chemical Name: Phenol formaldehyde resin.

Composition: Cross-linked condensation polymer of phenol, aniline and formaldehyde (40%); mica (58%); miscellaneous (2%).

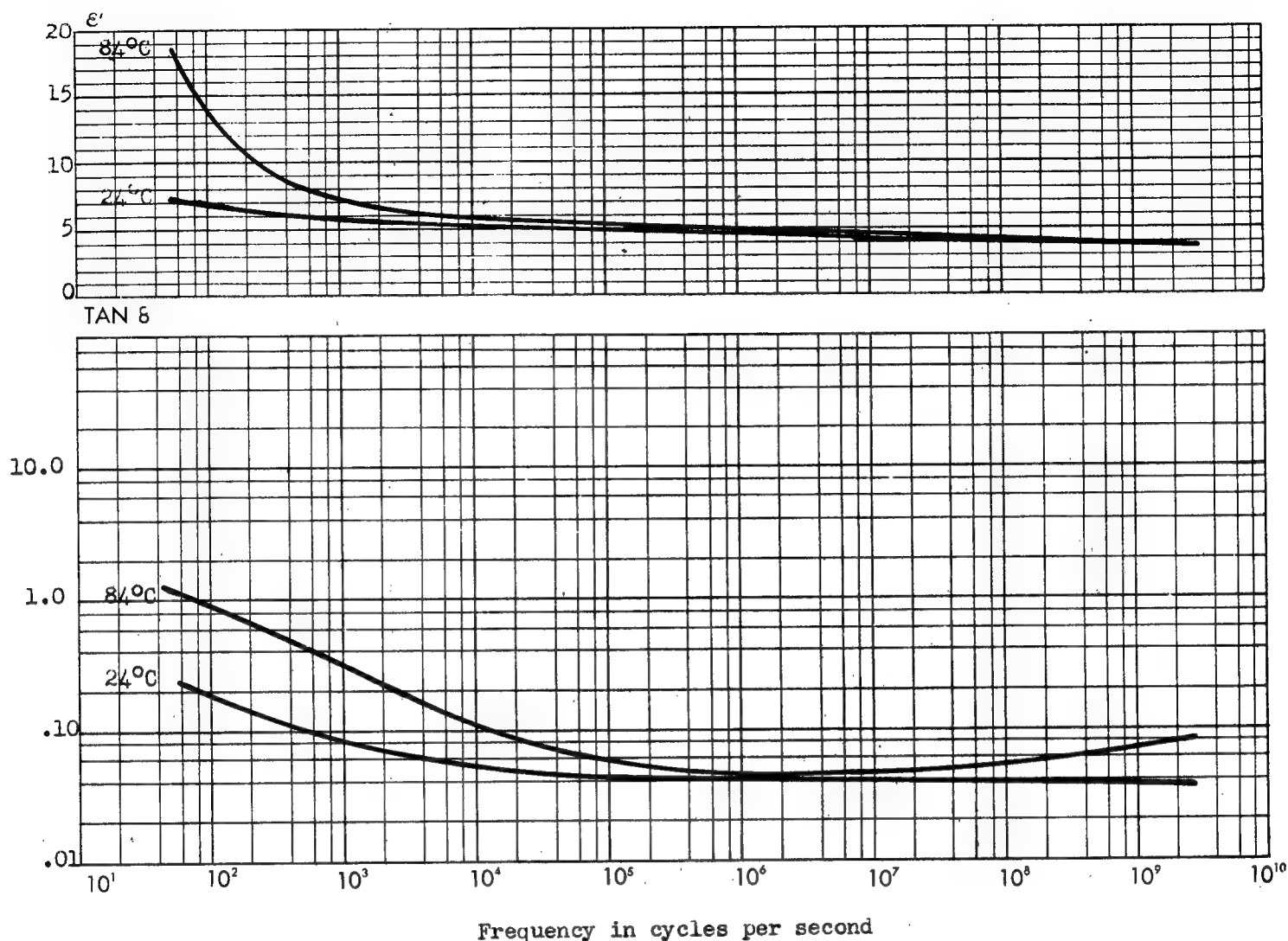
Properties: Light tan.  $d^{25}=1.83$ . Ten. Str. 6500. Rockwell M100. Imp.(Izod) 25°C, 0.32-0.40. Comp. Str. 17,000. Flex. Str. 25°C, 9000. Mach.: poor. Therm. Sta. 121°C.  $T_{dis} > 100^\circ\text{C}$ . Thermosetting. Chem. Res.: acids, good; weak alkalies, fair; solvents, good; water, excellent; oxygen, good. Sun.: discolors. Moist. Abs. 0.07% to 0.10%. Flam.: will not support combustion. Elec. Str. >400 step-by-step. Arc Res.: poor.

Methods of Handling: Compr. Mold. 160°C, 3000.

Recommended Uses: Low loss molding material for electrical uses: condenser housings, coil forms, etc.

Availability: Molding powder in production quantities.





Chemical Name: Phenol furfuraldehyde resin.

Composition: Cross-linked condensation polymer of phenol and furfuraldehyde without plasticizer or filler.

Properties: Opaque, black.  $d^{25}=1.23$ . Mach.: good. Therm. Sta.: slight shrinkage and hardening at  $149^\circ\text{C}$ . Thermosetting. Chem. Res.: weak acids, excellent; strong acids, poor; weak alkalies, excellent; strong alkalies, poor; alcohols and hydrocarbons, excellent; ketones, fair; water, excellent. Sun.: none. Moist. Abs. 0.06%. Flam.: extremely low.

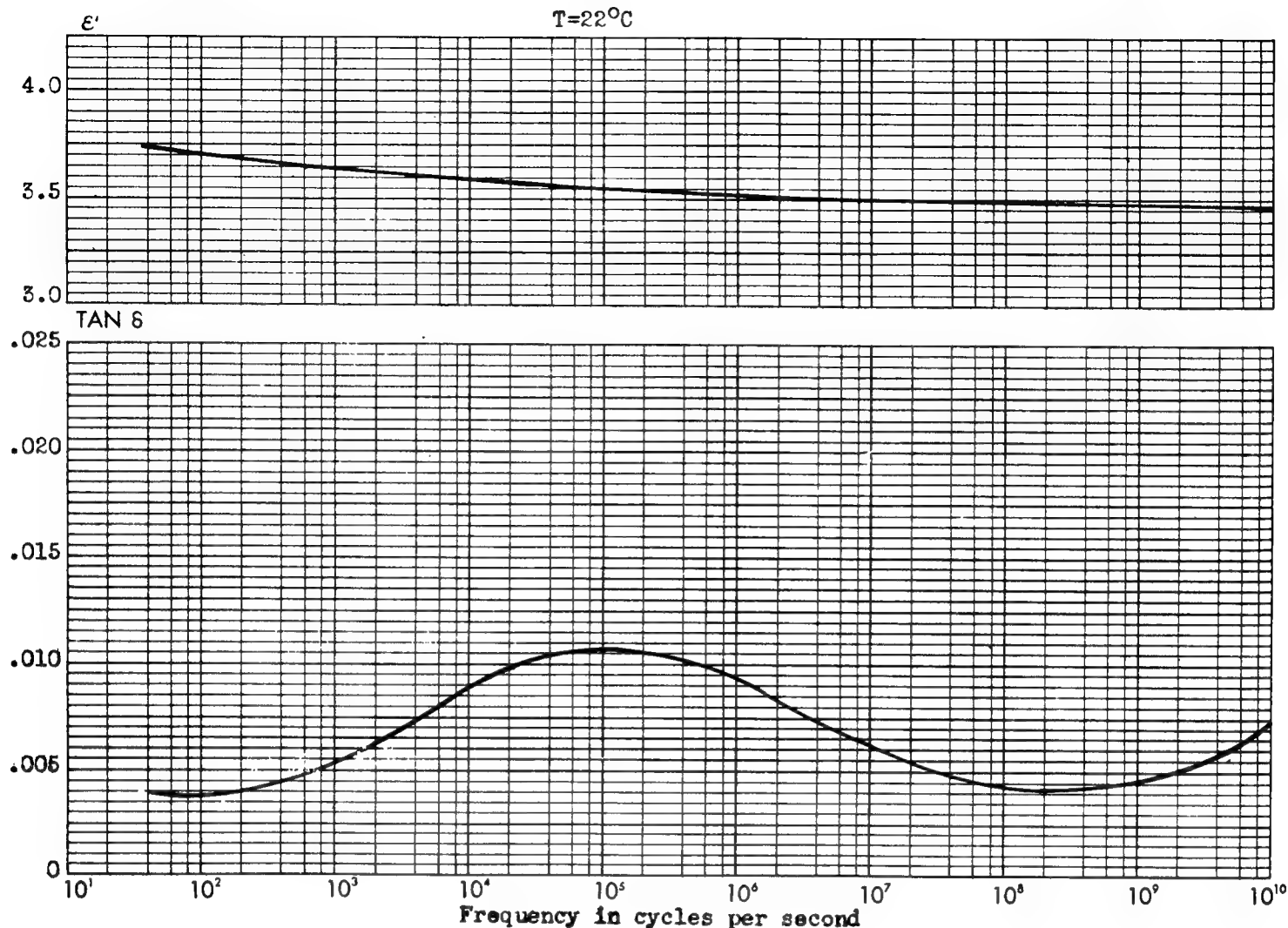
Methods of Handling: Compr. Mold.  $120-230^\circ\text{C}$ , 0-500; transfer molding including injection and extrusion also possible.

Recommended Uses: Printing plates, radio tube bases, coatings, waterproofing textiles, etc.

Availability: Molding powder in commercial quantities under allocation.

**NOTE:** This is one of the base resins for a large variety of "Durite" products.





**Chemical Name:** Aniline-formaldehyde resin.

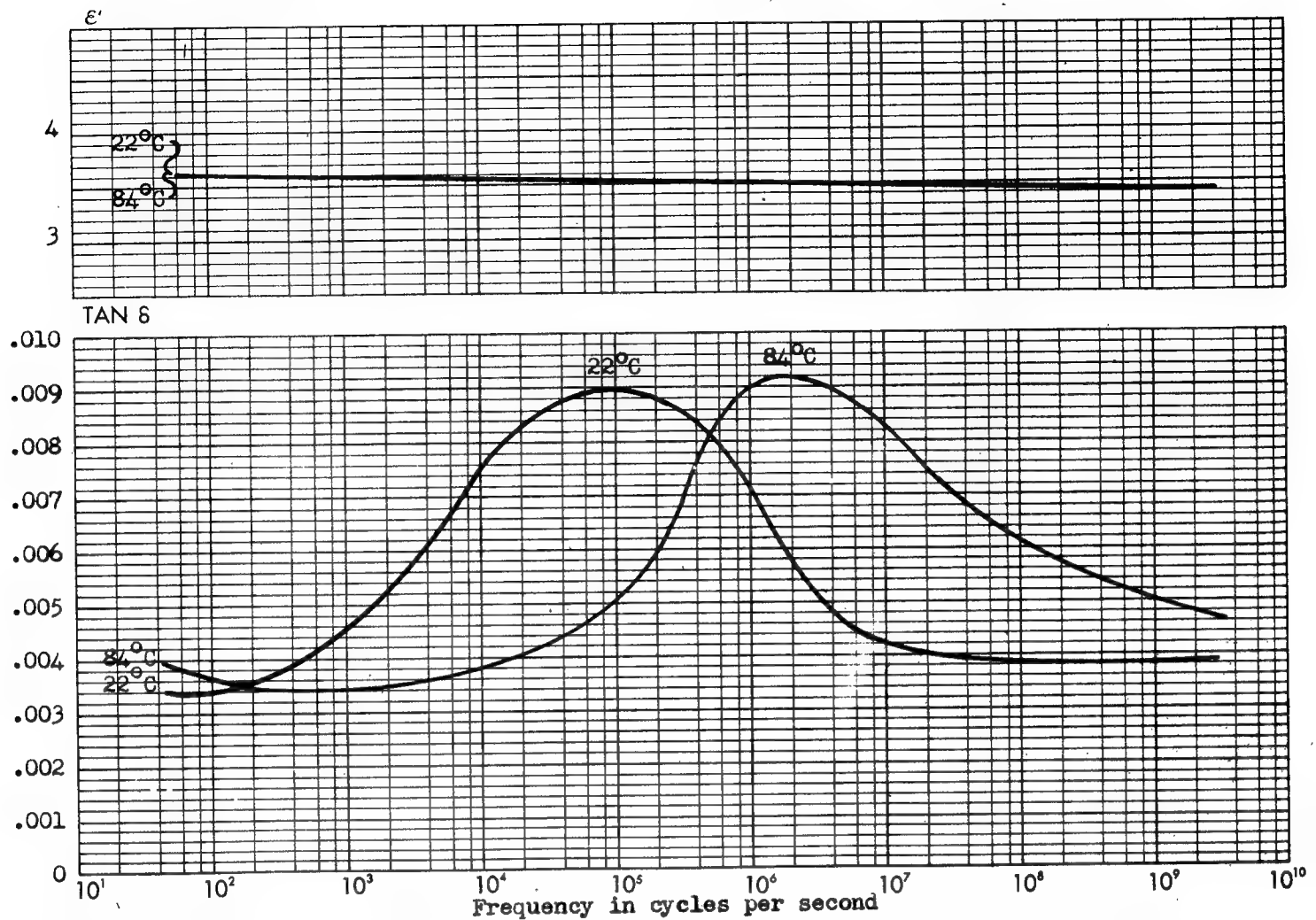
**Composition:** Cross-linked condensation polymer of aniline and formaldehyde(100%).

**Properties:** Brown translucent.  $d^{25}_4=1.22-1.25$ . Ten. Str. 8000-10,000. Rockwell M120. Imp.(Izod) C.3. Mod. El. 577,000-740,000. Comp. Str. 20,000-24,000. Flex. Str.  $25^{\circ}\text{C}$ , 12,000-17,000. Mach.: good to excellent. Spec. Heat 0.40. Therm. Exp.  $6.49 \times 10^{-5}$ .  $T_{dis}$   $115^{\circ}\text{C}$ .  $T_{soft}$   $126^{\circ}\text{C}$ . Therm. Sta.  $82-88^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: weak acids, fair; strong acids, poor; weak alkalies, good; strong alkalies, fair; solvents, excellent; water, excellent; oxygen, excellent. Sun.: darkens. Moist. Abs. 0.05-0.08%. Flam.: chars, will not support combustion. Elec. Str. 600 (1/8" thick) short time. Arc Res.: excellent.

**Methods of Handling:** Compr. Mold.  $149-171^{\circ}\text{C}$ , 1500-6000.

**Recommended Uses:** Electrical type resin recommended for any purpose where high frequency, good tensile strength and heat resistance is required.

**Availability:** Molding powder in production quantities - priority required.



**Composition:** Cross-linked condensation polymer of aniline and formaldehyde (100%).

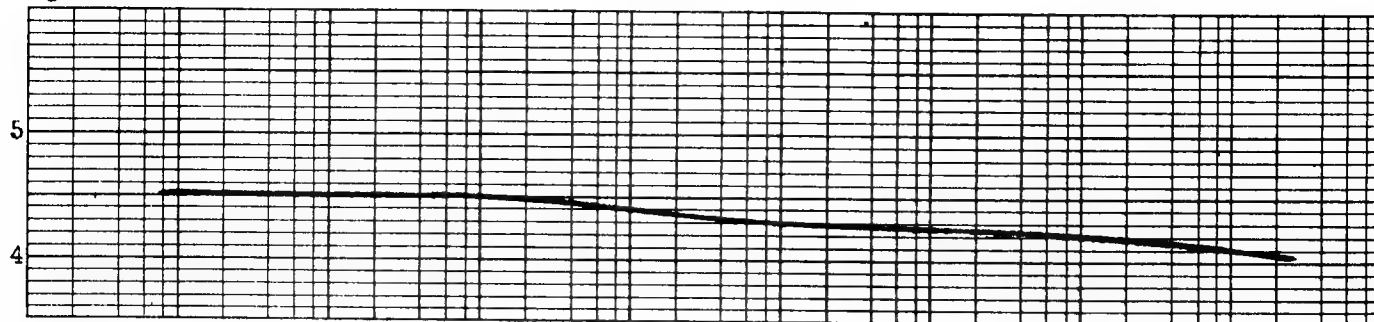
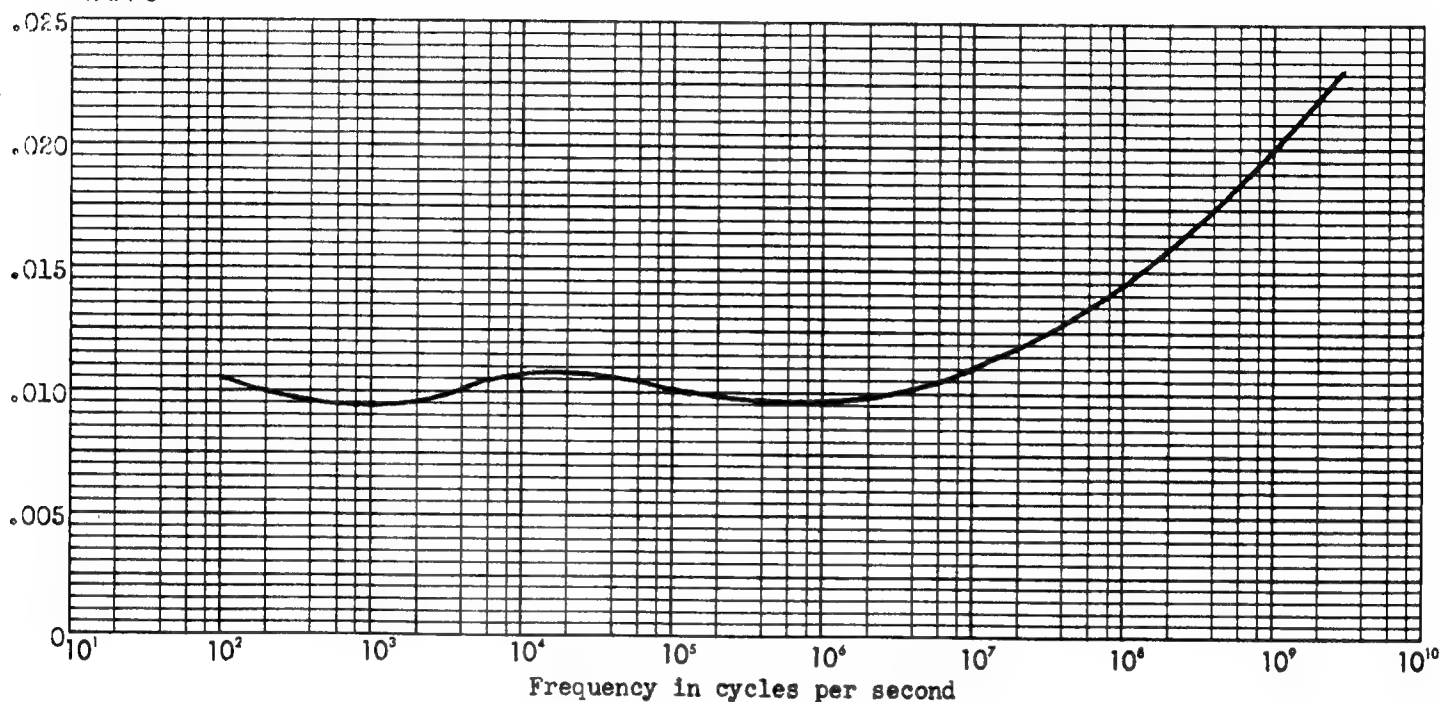
**Properties:** Reddish brown, translucent.  $d_{25}^{25}=1.21$ . Ten. Str. 7,500-12,200; av. 10,000. Rockwell: 25°C M117-125, 90°C M104-113. Shore 85-95. Imp.(Izod):0.30-0.44, av. 0.34. Mod. El. 532,000-912,000; av. 740,000. Comp. Str. 14,000-22,400; av. 20,000. Flex. Str. 15,200-23,000; av. 20,000. Mach.: very good. Therm. Exp.  $5.4 \times 10^{-5}$ . Therm. Sta.: heat increases the softening point and causes embrittlement. Thermoplastic. Chem. Res.: acids, attacked slightly by weak acids and definitely attacked by strong acids; alkalies, excellent; solvents, excellent for common organic solvents; water, excellent; oxygen, slight darkening. Sun.: discoloration and slight darkening. Moist. Abs. 0.06-0.08%. Flam.: will not support combustion.

**Methods of Handling:** Compr. Mold. 160°C, 1200 or more.

**Recommended Uses:** At the present time, it is being used largely in high frequency equipment for war purposes.

**Availability:** Dilectene is now being supplied in the following forms: Sheets - about 13" x 35" x 1/16" to 1" thick; Rods - 3/16" to 1 1/8" in diameter by about 35" long, also shorter lengths of thicker rods in limited quantities.

T=25.5°C

 $\epsilon'$ TAN  $\delta$ 

Frequency in cycles per second

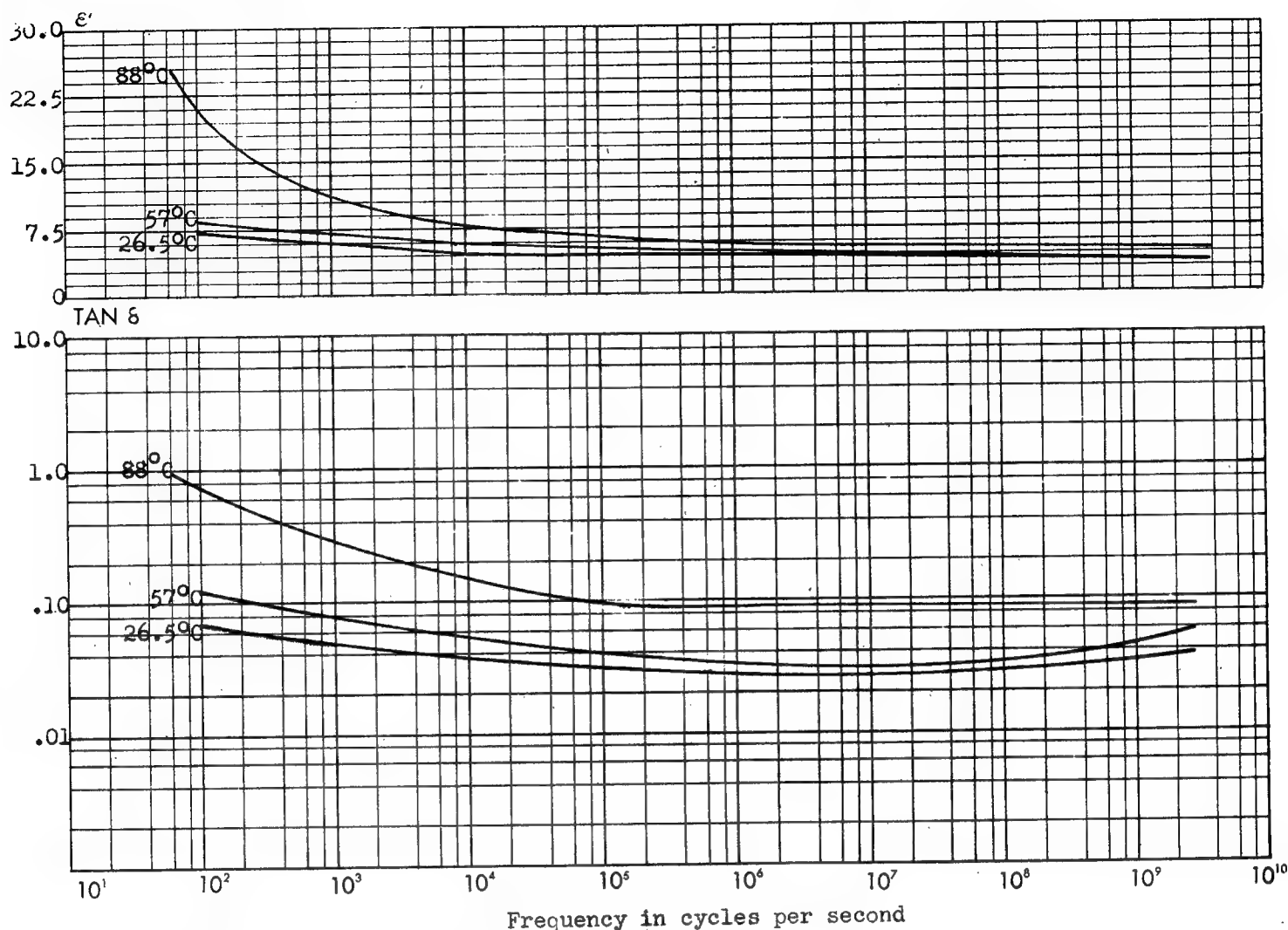
Chemical Name: Aniline-formaldehyde resin plus glass.

Composition: Cross-linked condensation polymer of aniline and formaldehyde (55%); phenol formaldehyde (5%) as binder for glass mat laminate (40%).

Properties: Translucent dark amber, polished.  $d^{25}=1.5$ . Ten. Str. 10,000. Rockwell M100. Imp.(Izod): flatwise 1.6; edgewise 1.5. Mod. El.  $12 \times 10^5$ . Comp. Str.: flatwise 42,000; edgewise 32,000. Flex. Str.: flatwise 12,500; edgewise 13,500. Mach.: good. Therm. Exp.  $1.7 \times 10^{-5}$ . Therm. Sta. 104°C. Thermosetting. Chem. Res.: oxidizing acids, poor; other acids, good to fair; weak alkalis, good; strong alkalis, poor; solvents, good; water, good; oxygen, good. Moist. Abs. 0.6%. Elec. Str.: perpendicular to lams. 450; parallel to lams. 70. Surf. Res.  $>10^8$ . Arc Res.: poor.

Recommended Uses: High frequency insulation; coil forms, condenser spacers, antenna mast insulators, molded shapes, etc.

Availability: Sheets, rods, tubes and molded parts in production quantities - resin allocated, glass not allocated at present.



Chemical Name: Melamine-formaldehyde resin. Sample Designation: Batch WB44

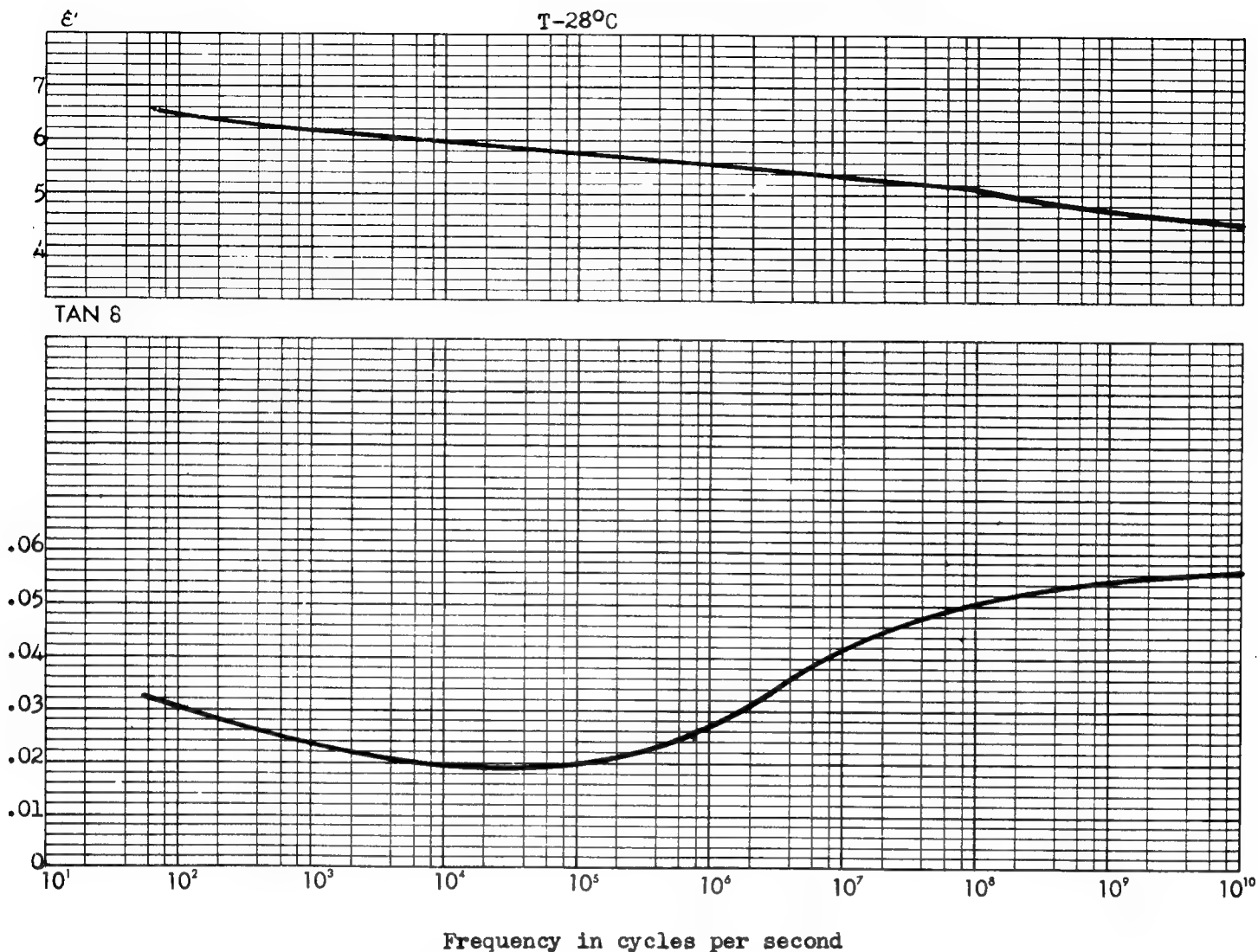
Composition: Cross-linked condensation polymer of melamine and formaldehyde.

Properties: Brown.  $d_{25}^{25}=1.68$ . Ten. Str. 6000. Rockwell M112. Imp.(Izod) 0.35, 25°C. Mod. El.  $10 \times 10^5$ . Comp. Str. 30,000. Flex. Str. 8000, 25°C. Mach.: fair. Therm. Exp.  $3.5 \times 10^{-5}$ . Tdis 125°C. Therm. Sta. 149°C. Thermosetting. Chem. Res.: acids, good; alkalies, good; solvents, good; water, excellent; oxygen, good. Sun.: none. Moist. Abs. 0.1%. Flam.: self-extinguishing. Elec. Str. 450, short time. Arc Res.: good.

Methods of Handling: Compr. Mold. 143-177°C, 2000.

Recommended Uses: Electrical insulation.

Availability: Commercial production.



Chemical Name: Urea-formaldehyde resin. Sample Designation: 20 RC W-48

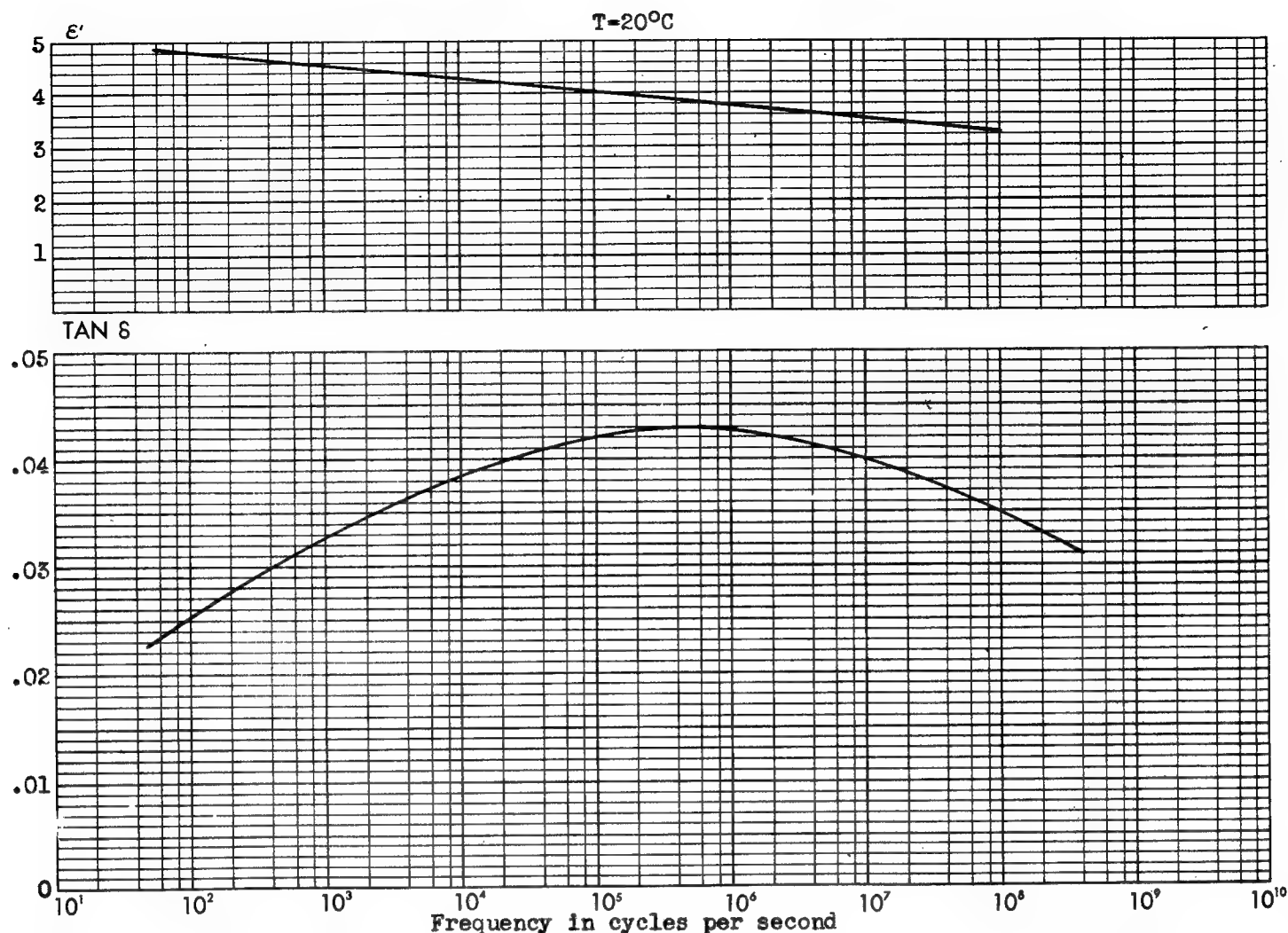
Composition: Cross-linked condensation polymer of urea and formaldehyde.

Properties: Translucent.  $d^{25}=1.50$ . Ten. Str. 9000. Rockwell M120. Imp.(Izod) 0.32,  $25^{\circ}\text{C}$ . Mod. El.: flexure,  $14 \times 10^5$ . Comp. Str. 29,000. Flex. Str. 13,000;  $25^{\circ}\text{C}$ . Mach.: fair. Spec. Heat 0.4. Therm. Exp.  $2.6 \times 10^{-5}$ . Therm. Cond.  $7.0 \times 10^{-4}$ . Tdis  $152^{\circ}\text{C}$ . Therm. Sta.  $82^{\circ}\text{C}$ . Thermosetting. Chem. Res.: weak acids, fair; weak alkalies, fair; solvents, good; water, absorbs and loses; oxygen, good. Sun.: none. Moist. Abs. 2%. Flam.: slow. Elec. Str. 375 (.085" thick), short time. Arc Res.: good.  $n_D=1.54$ .

Methods of Handling: Compr. Mold.  $132-177^{\circ}\text{C}$ , 1800.

Recommended Uses: Compression molded parts.

Availability: Commercial production under allocation.



**Chemical Name:** Cellulose acetate plastic **Sample Designation:** Research Sample C-1686

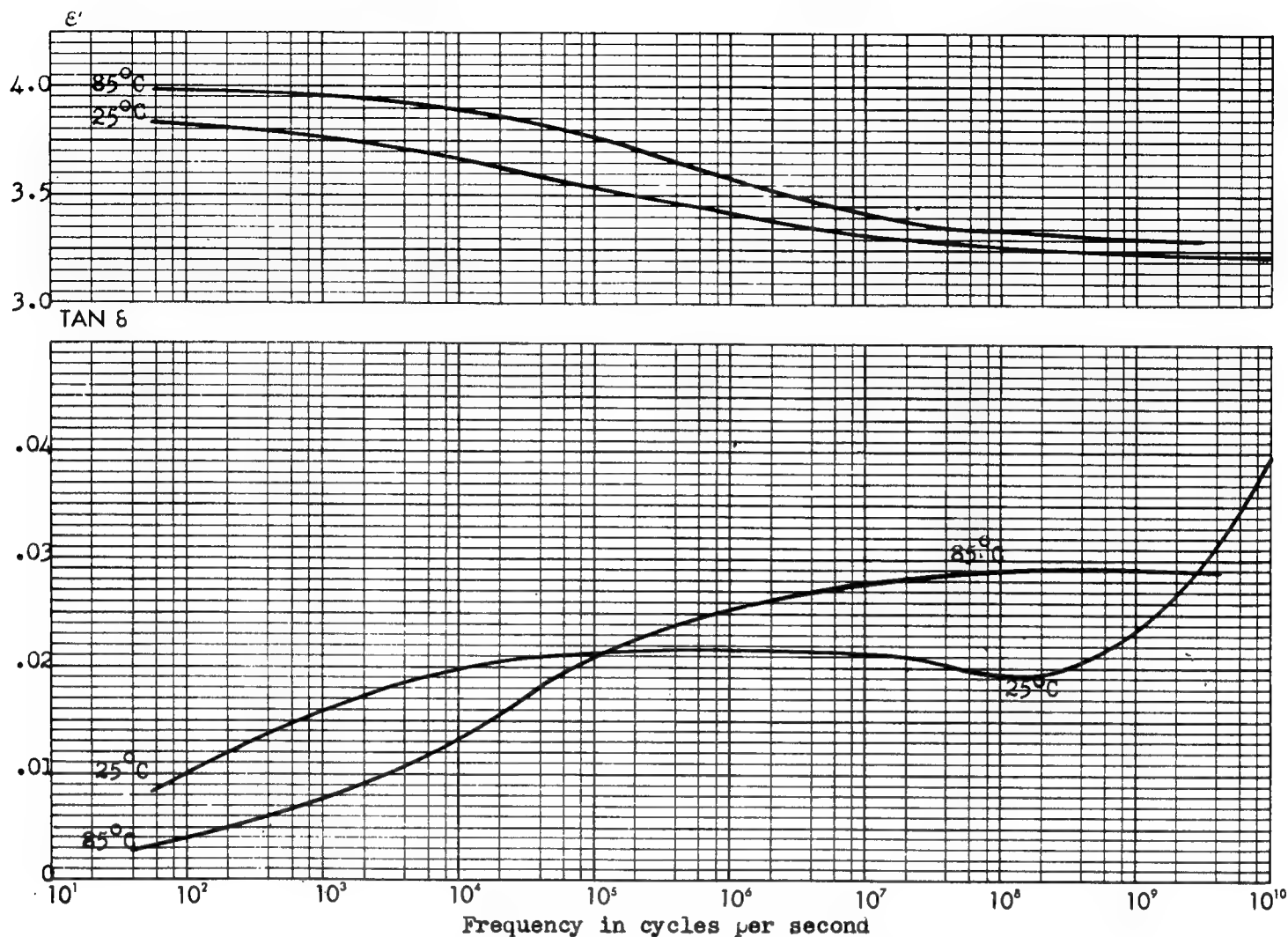
**Composition:** Chemicals - cellulose, acetic anhydride. Ester of natural linear polymer. 71.7% cellulose acetate, 26.2% plasticizer and 2.0% residual solvent and water.

**Properties:** Transparent, colorless to slightly yellow.  $d_{20}^{20}=1.31$ . Ten. Str. 4500-5000. Rockwell M25-30. Imp.(Charpy):  $-40^{\circ}\text{C}$  0.5-0.6;  $25^{\circ}\text{C}$  2.5-3.0. (Izod)  $-40^{\circ}\text{C}$  0.3-0.5;  $25^{\circ}\text{C}$  2.2-2.6. Mod. El.  $2.1-2.5 \times 10^5$ . Comp. Str. 25,000-30,000. Shear. Str. (double shear) 5000-6000. Flex. Str. (Tour-Marshall):  $-40^{\circ}\text{C}$  23,000-28,000;  $25^{\circ}\text{C}$  6000-8000. Elong. 35-45%. Mach.: excellent. Spec. Heat 0.35. Therm. Exp.  $6-15 \times 10^{-5}$ . Therm. Cond.  $4-6 \times 10^{-4}$ .  $T_{dis}$   $57-63^{\circ}\text{C}$ .  $T_{soft}$   $60-90^{\circ}\text{C}$ . Therm. Sta.: should not be stressed at temps. above  $50-55^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids, conc. poor, weak fair to good; alkalis, conc. poor, weak fair; solvents, soluble in ketones, esters, ethylene dichloride-alcohol mixtures; insoluble in alcohols, hydrocarbons, oils; water, fairly good; oxygen, good. Sun.: loss of plasticizer and embrittlement on long exposure. Moist. Abs. 1.5-2.0%. Flam. 0-1.5 in./min. Elec. Str. 250-350 (125 mil thick). Surf. Cond.  $3-5 \times 10^{13}$ . Arc Res.: fair.  $n_D=1.49-1.50$ .

**Recommended Uses:** Transparent enclosures for aircraft, etc., instrument covers, oil gauges, transparent covers, protective shields, goggles, lighting equipment, handles, gaskets and spacers, nameplates, etc.

**Availability:** Commercial product - sheet form in colors. Available in special forms for molding, extrusion, coating, etc.





**Chemical Name:** Cellulose acetate **Sample Designation:** Lot 5253

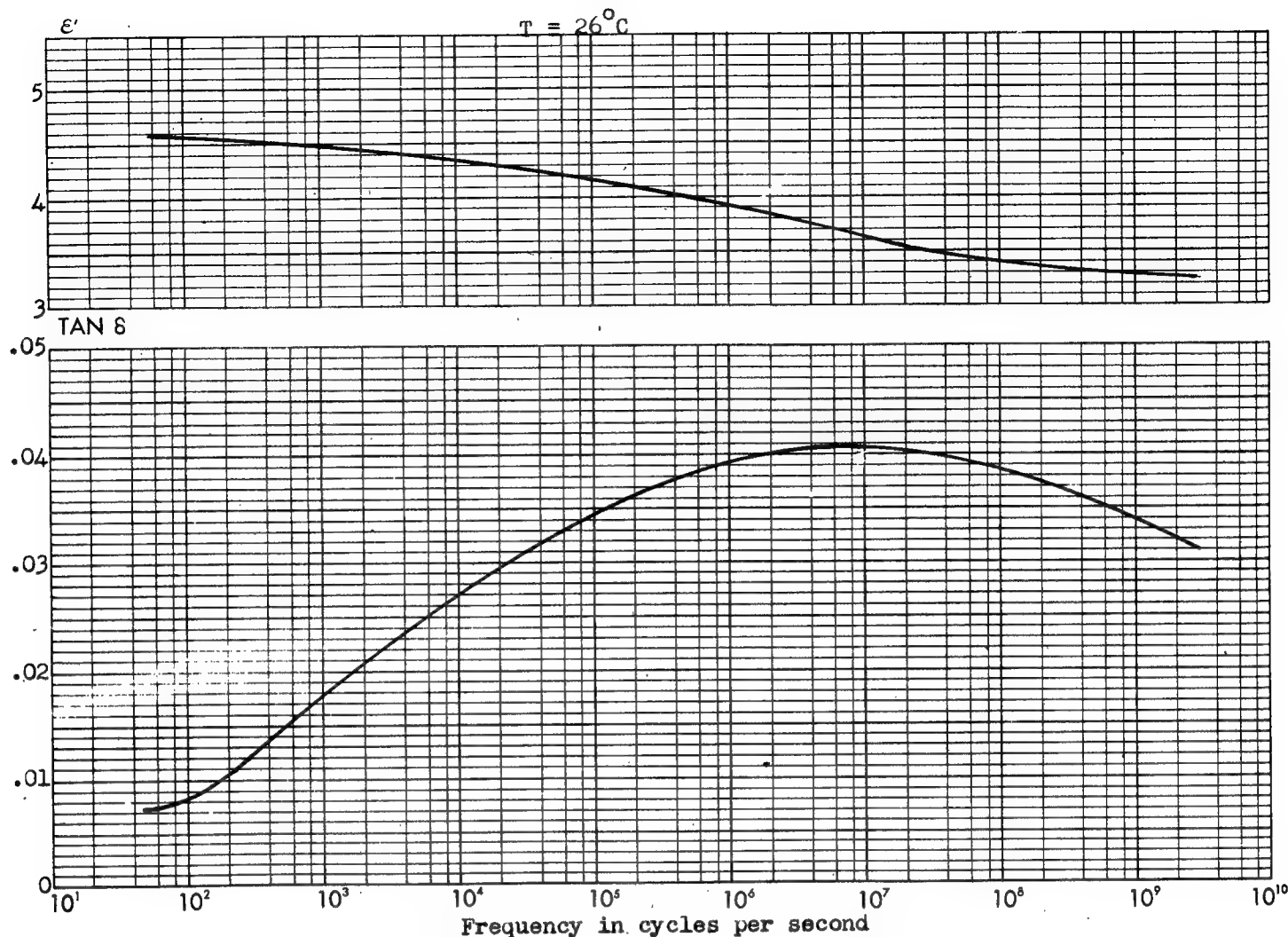
**Composition:** Acetic ester of cellulose, a natural linear polymer. Unplasticized. Combined acetic acid 55.4%.

**Properties:** White, opaque flakes.  $d_{25}^{25}=1.4$  (in film form). Ten. Str. 9600 (cast film). Hardness 78% (Sword Rocker). Elong. 3.3%. Thermoplastic. Chem. Res.: acids, fair to poor; alkalis, fair to poor; acetone and alcohol, poor; aromatic and aliphatic hydrocarbons, good; water, excellent; oxygen, excellent. Sun.: slight discoloration. Moist. Abs. 6-10%. Flam.: 1.3 in./sec. on .001" film. Elec. Str. 1400 (1 mil film); 3000 (.0012" film). Arc Res.: good.  $n_D=1.48$ .

**Methods of Handling:** Lacquer: possible.

**Recommended Uses:** In lacquers or insulating varnishes. Other varieties of cellulose acetate are available, used in plastics either as sheet, rod, tube or molding powder or as cast foil or film. Most of these forms are plasticized with such materials as phosphates or phthalates.

**Availability:** Granular molding powder in commercial quantities.



**Chemical Name:** Cellulose acetate molding composition.

**Composition:** Ester of a natural linear polymer, cellulose acetate (69-77%) plasticizer (23-31%) and coloring agents i.e. pigments and dyes.

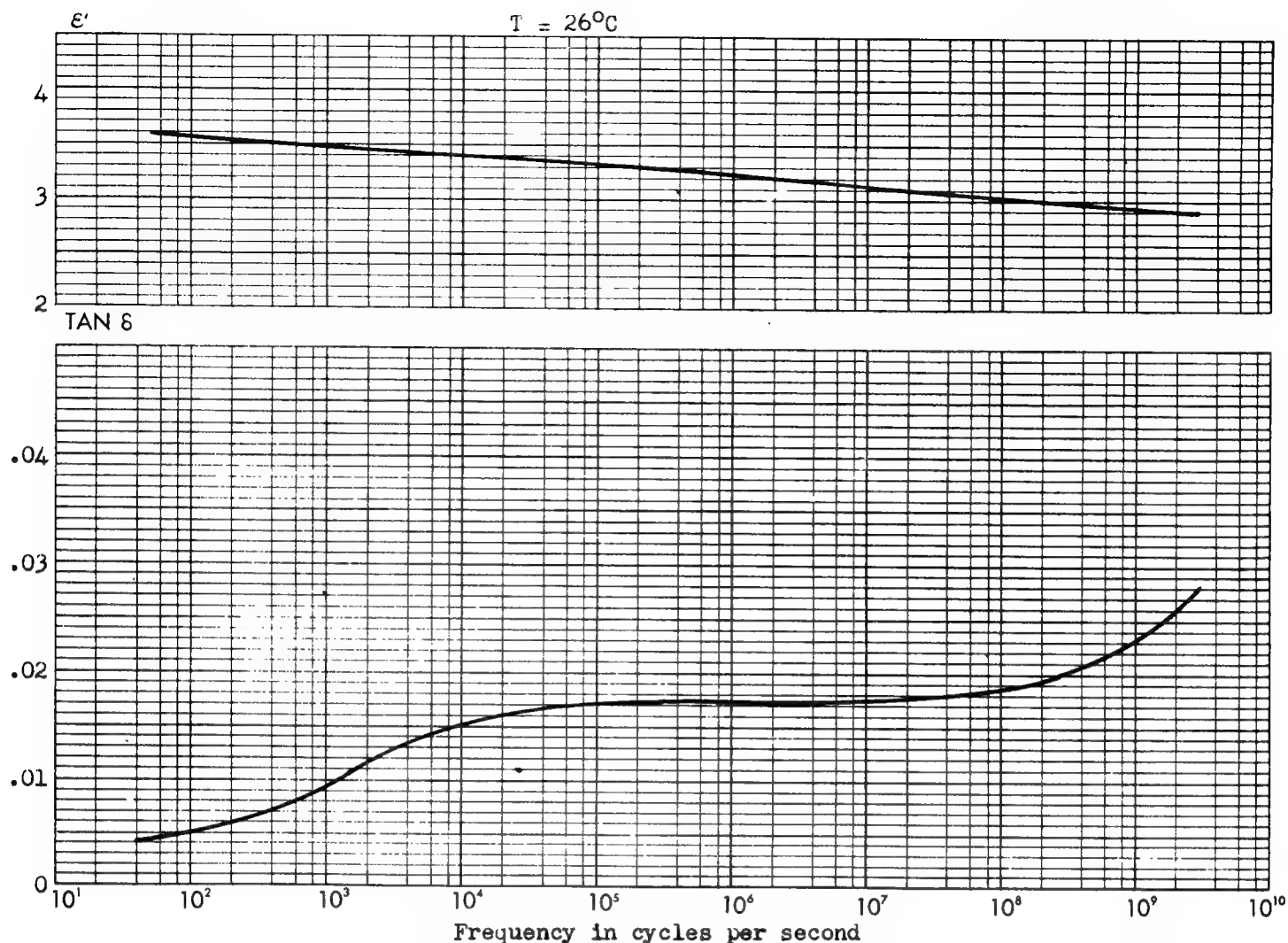
**Properties:** Similar products in all colors, clear transparents to opaque.  $d_{25}^{25}=1.31$ .  
**Ten. Str.:**  $-40^{\circ}\text{C}$ , 10,100;  $25^{\circ}\text{C}$ , 6500;  $76^{\circ}\text{C}$ , 3900. Rockwell M73. Imp.(Izod):  $-40^{\circ}\text{C}$ , 0.5;  $25^{\circ}\text{C}$ , 1.4. Mod. El.:  $-40^{\circ}\text{C}$ ,  $3.00 \times 10^5$ ;  $25^{\circ}\text{C}$ ,  $2.50 \times 10^5$ ;  $76^{\circ}\text{C}$ ,  $1.7 \times 10^5$ . Comp. Str. 7000-25,000. Flex. Str.:  $-40^{\circ}\text{C}$ , 21,200;  $25^{\circ}\text{C}$ , 11,600;  $76^{\circ}\text{C}$ , 7800. Elong. 25%.  
**Mach.:** excellent. Spec. Heat 0.3-0.45. Therm. Exp.  $8-16 \times 10^{-5}$ . Therm. Cond.  $4-8 \times 10^{-4}$ .  
 $T_{dis}$   $85^{\circ}\text{C}$ .  $T_{soft}$   $60-121^{\circ}\text{C}$ . Therm. Sta.  $77^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids, good; alkalies, good; solvents, soluble in some ketones, chlorinated hydrocarbons and esters; water, some leaching of plasticizer on continuous immersion; oxygen, excellent.  
**Sun.:** slight. Moist. Abs. 2.9% Flam.:  $< 2.5$  in./min. Elec. Str. 290-600.  $n_D=1.46-1.50$ .

**Methods of Handling:** Compr. Mold.  $127-199^{\circ}\text{C}$ , 500-5000; Inj. Mold.  $171-232^{\circ}\text{C}$ , 8000-32,000; Extr.  $171-232^{\circ}\text{C}$ .

**Recommended Uses:** Automobile steering wheels; panels and controls; separable fasteners (zippers); radio housings, panels and knobs; vacuum cleaner nozzles and housings; oil containers; household hardware; games and toys; combs; costume jewelry; fishing tackle; industrial goggles; business machine keys and parts; thermostat and thermometer housings; saw and screw driver handles; refrigerator shelf lugs.

**Availability:** Molding powder and sheets in commercial quantities under allocation.





**Chemical Name:** Cellulose acetate butyrate molding compound.

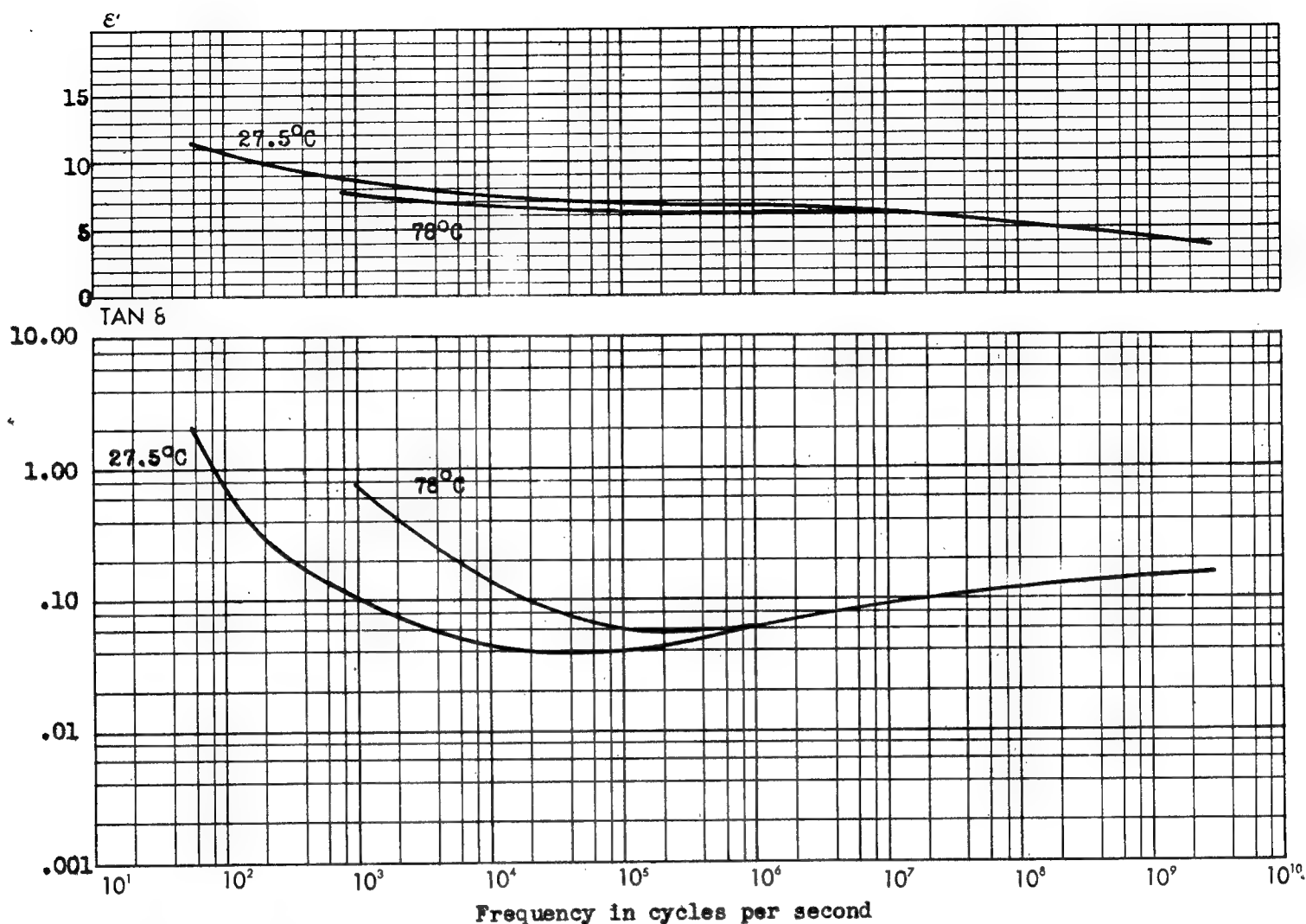
**Composition:** Ester of a natural linear polymer, cellulose acetate butyrate (85-95%), plasticizer (5-15%) and coloring agents i.e. pigments and dyes.

**Properties:** Similar products in all colors, clear transparent to opaque.  $d_{25}^{25}=1.22$ . Ten. Str.:  $-40^\circ\text{C}$ , 9400;  $25^\circ\text{C}$ , 6100;  $76^\circ\text{C}$ , 3900. Rockwell M67. Imp.(Izod):  $-40^\circ\text{C}$ , 0.5;  $25^\circ\text{C}$ , 1.0. Mod. El.:  $-40^\circ\text{C}$ ,  $1.99 \times 10^5$ ;  $25^\circ\text{C}$ ,  $1.69 \times 10^5$ ;  $76^\circ\text{C}$ ,  $1.10 \times 10^5$ . Comp. Str. 7000-21,000. Flex. Str.:  $-40^\circ\text{C}$ , 15,800;  $25^\circ\text{C}$ , 10,000;  $76^\circ\text{C}$ , 5300. Elong. 42%. Mach.: excellent. Spec. Heat 0.3-0.4. Therm. Exp.  $11-17 \times 10^{-5}$ . Therm. Cond.  $4-8 \times 10^{-4}$ .  $T_{dis}$   $75^\circ\text{C}$ .  $T_{soft}$   $60-121^\circ\text{C}$ . Therm. Sta.  $77^\circ\text{C}$ . Thermoplastic. Chem. Res.: acids, good; alkalis, good; solvents, soluble in some ketones, chlorinated hydrocarbons and esters; water, good; oxygen, excellent. Sun.: slight. Moist. Abs. 2.3%. Flam.:  $<1.5$  in./min. Elec. Str. 250-400.  $n_D=1.47-1.49$ .

**Methods of Handling:** Compr. Mold.  $127-188^\circ\text{C}$ , 500-5000; Inj. Mold.  $171-216^\circ\text{C}$ , 8000-32,000; Extr.  $171-216^\circ\text{C}$ . Lacquer: gel lacquers; solvents, Solvesso #2, toluene and isopropyl alcohol.

**Recommended Uses:** Gun stocks; telephones; automobile steering wheels and panels; flashlight housings; radio housings, panels and knobs; vacuum cleaner nozzles and housings; household hardware; business machine keys and parts; thermostat and thermometer housings.

**Availability:** Molding powder and sheets in commercial quantities under allocation.



**Chemical Name:** Cellulose nitrate

**Composition:** Cellulose nitrate plus camphor (ca. 25%).

**Properties:** Clear, yellow.  $d^{25}_D = 1.35-1.40$ . Ten. Str. 7000. Rockwell R111.

Imp. (Izod):  $-40^\circ\text{C}$ , 0.75;  $25^\circ\text{C}$ , 4.0. Mod. El.  $2-4 \times 10^5$ . Shear. Str. 5000.

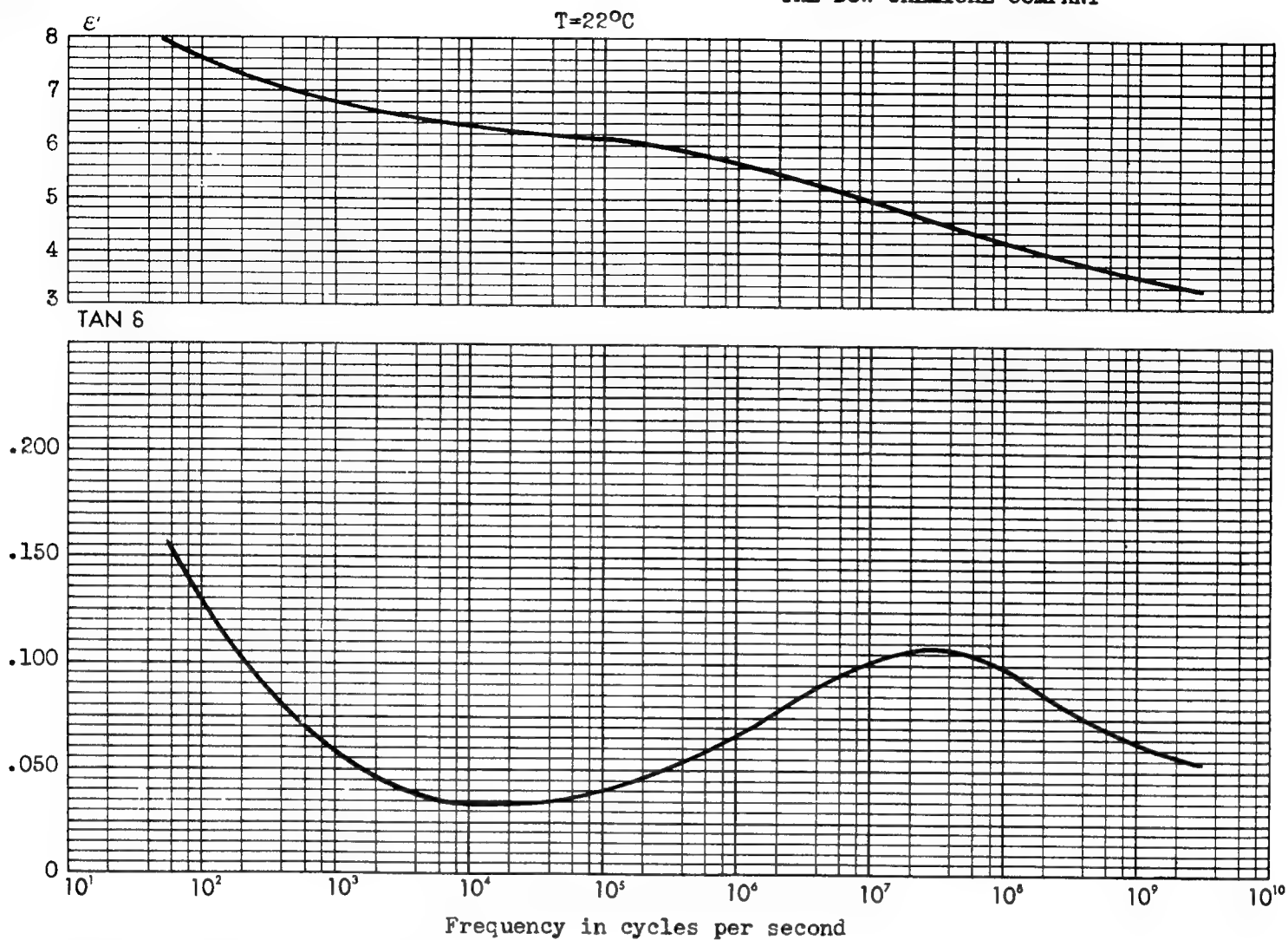
Flex. Str.  $25^\circ\text{C}$ , 9000. Elong. 25% min. Spec. Heat 0.36. Therm. Exp.  $9.8 \times 10^{-5}$ .

Therm. Cond.  $4.1 \times 10^{-4}$ . Thermoplastic. Chem. Res.: weak acids, good; weak alkalies, good; hydrocarbons, good; ketones, esters and alcohols, poor. Sun.: discolors, embrittles.

Moist. Abs. 2.0%. Flam.: very high  $n_D = 1.50$ .

**Recommended Uses:** Drawing and calculating instruments, instrument dials and crystals, film base, optical frames, fountain pens and pencils, brush-handles, wooden-heel covers, hammer-heads, tool handles, enclosures for light airplanes, coverings for sanitary fittings, advertising novelties and safety glass for safety goggles.

**Availability:** Sheets, rods and tubes in production quantities.



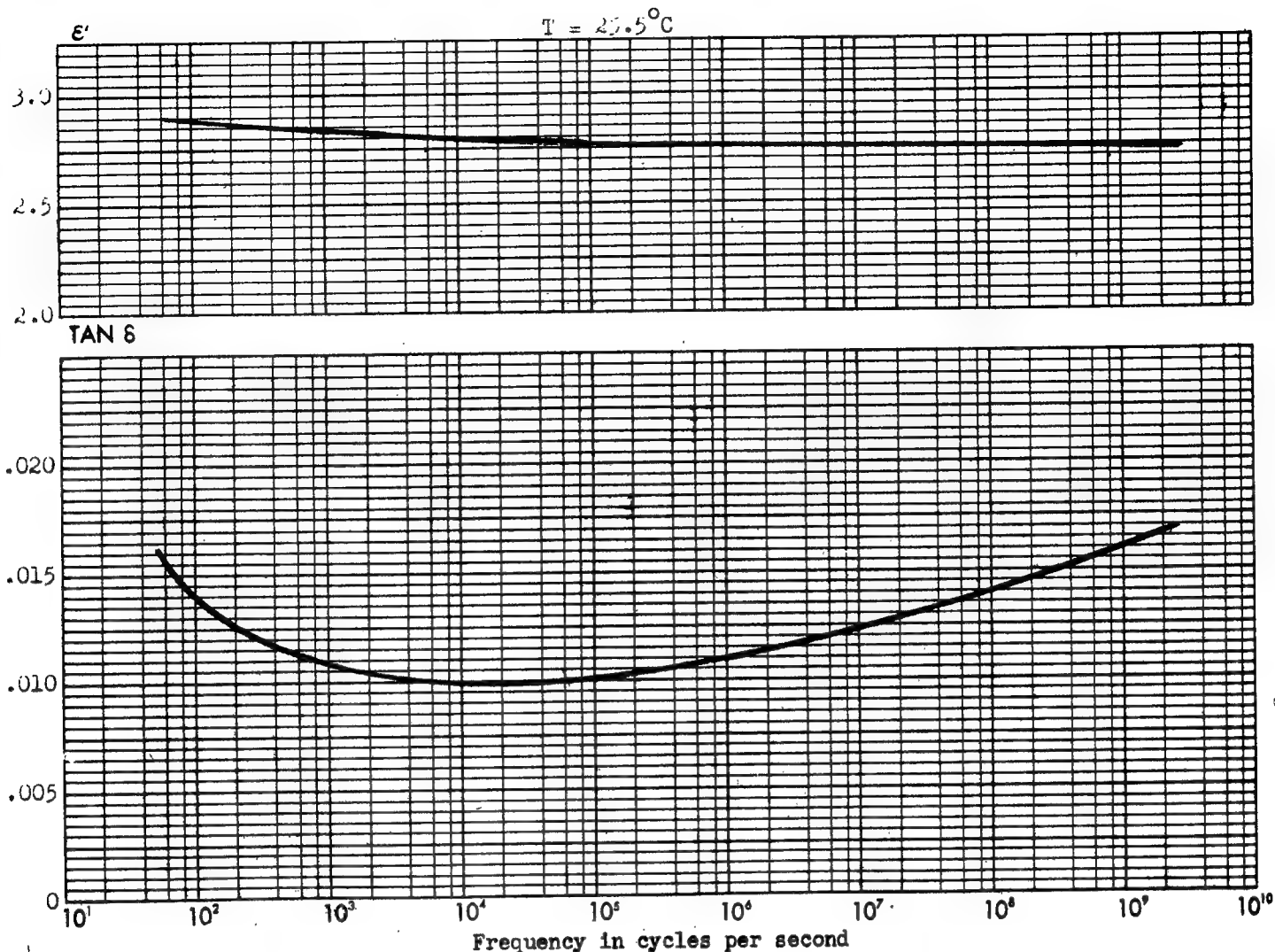
Chemical Name: Methyl cellulose.

Composition: Methyl ether of cellulose, a natural linear polymer prepared from cellulose, caustic soda and methyl chloride.

Properties: solvent, water.

Recommended Uses: Oil resistant coatings; thickening and dispersion agent.

Availability: Limited production; not allocated.



Chemical Name: Ethyl cellulose plastic.

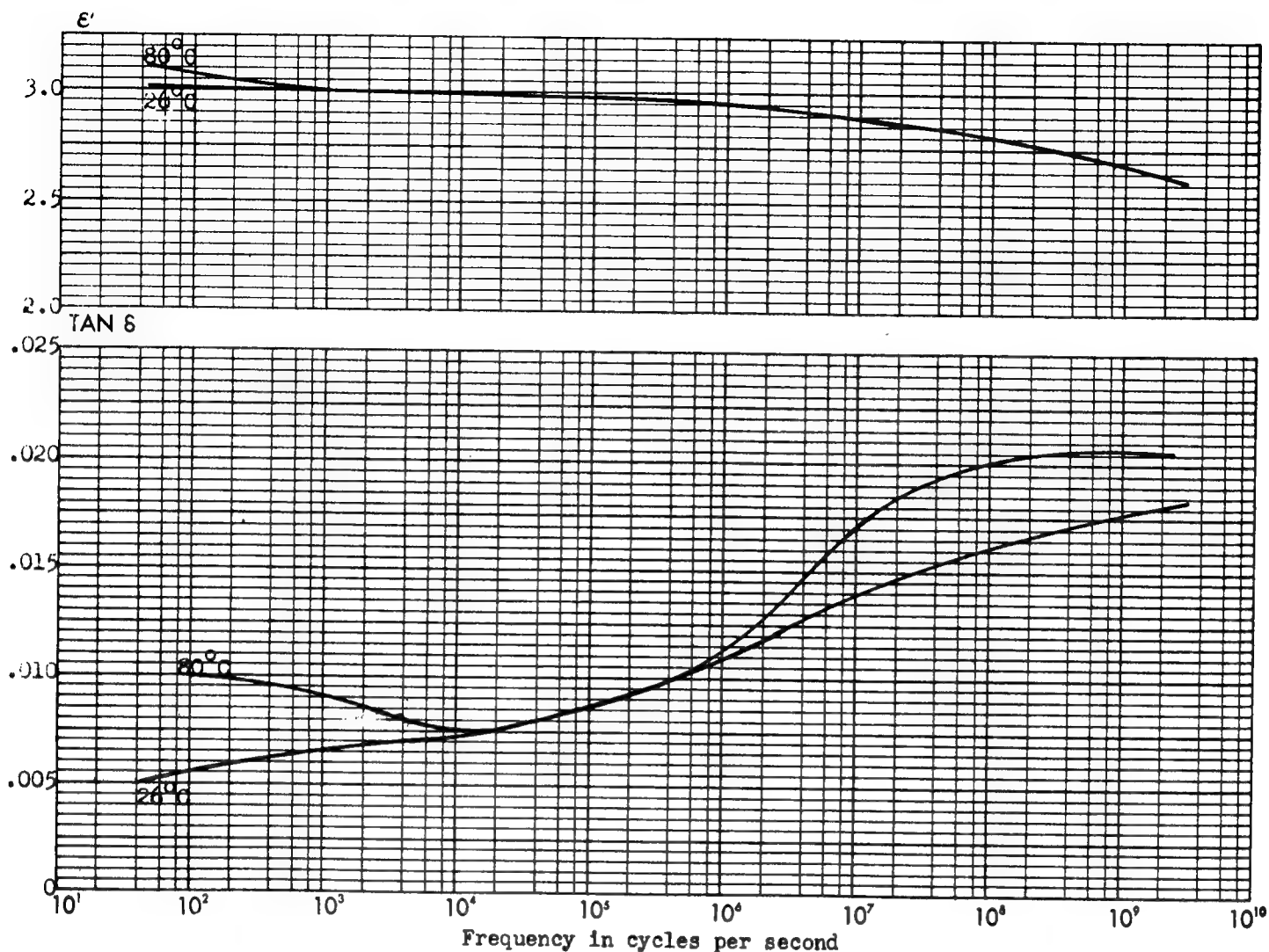
Composition: Linear addition polymer under secrecy order.

Properties: Transparent brown.  $d_{25}^{25}=1.08$ . Ten. Str. 9000. Imp.(Izod):  $-40^\circ\text{C}$ , 0.8;  $25^\circ\text{C}$  3.5;  $80^\circ\text{C}$  6.0. Elong. 6%. Mach.: good.  $T_{dis}$   $71^\circ\text{C}$ . Therm. Sta.  $65^\circ\text{C}$ . Thermoplastic. Chem. Res.: weak acids, good; strong acids, poor; alkalies, good; alcohols, esters, ketones and aromatic hydrocarbons, poor; water, good; oxygen, good. Sun.: slight. Moist. Abs. 1.4%.

Methods of Handling: Compr. Mold.  $150^\circ\text{C}$ , 2000; Inj. Mold.  $160^\circ\text{C}$ , 6000; Extr.  $160-170^\circ\text{C}$ .

Recommended Uses: Molded parts of good appearance and machining quality.

Availability: Molding powder in production quantities under allocation.



Chemical Name: Ethyl cellulose plastic.

Composition: Linear addition polymer under secrecy order.

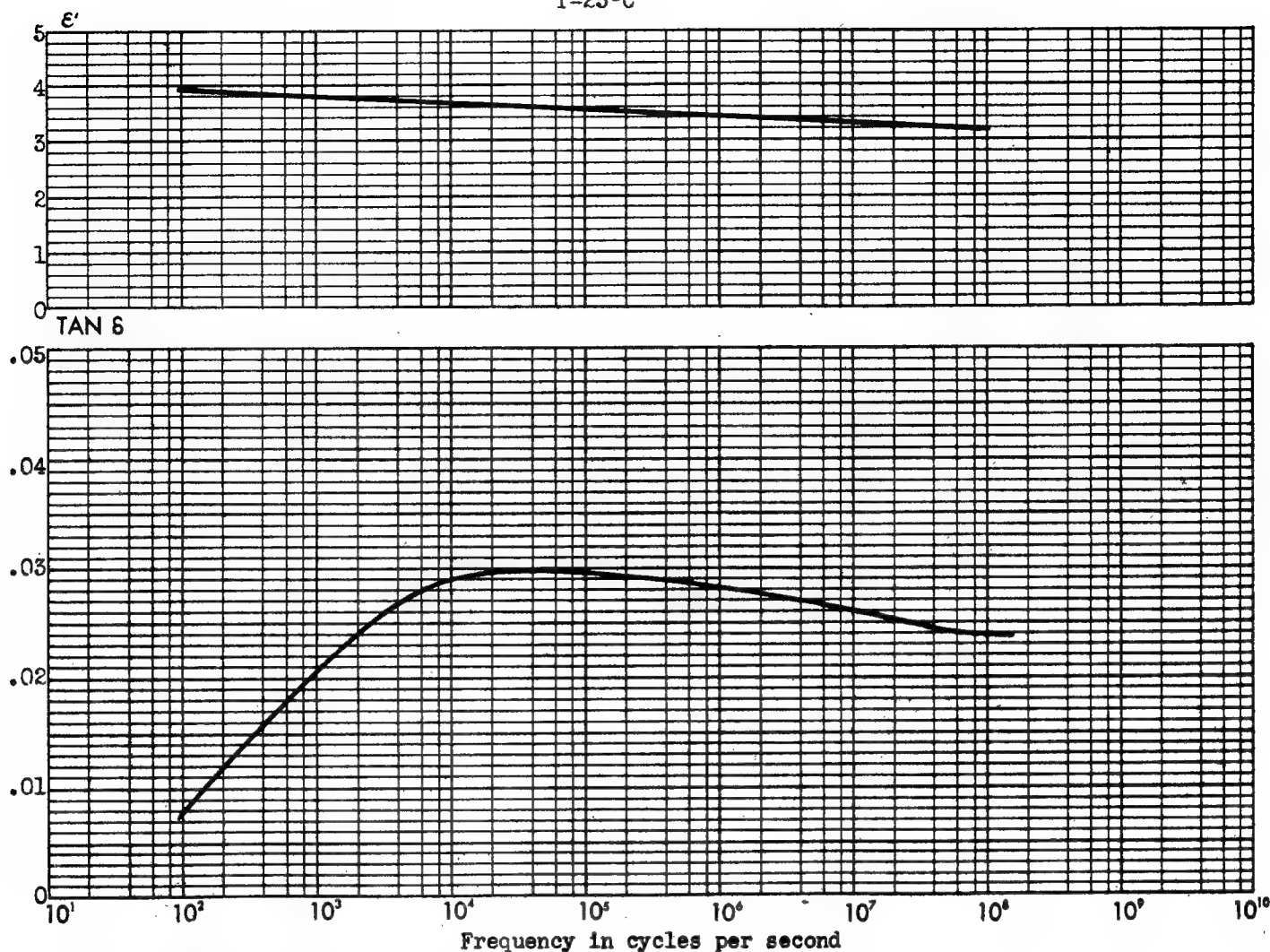
Properties: Clear.  $d_{25}^{25}=1.09$ . Ten. Str. 8000. Imp.(Izod): -40°C 1.0; 25°C 3.5; 80°C 6.0. Elong. 8%. Mach.: good. Tdis 74°C. Therm. Sta. 65°C. Thermoplastic. Chem. Res.: weak acids, good; strong acids, poor; alkalies, good; alcohols, esters, ketones and aromatic hydrocarbons, poor; water, good; oxygen, good. Sun.: slight. Moist. Abs. 1.4%.

Methods of Handling: Compr. Mold. 150°C, 2000; Inj. Mold. 160°C, 6000; Extr. 160-170°C.

Recommended Uses: Molded parts of good appearance and machining quality.

Availability: Molding powder in production quantities under allocation.

T=25°C



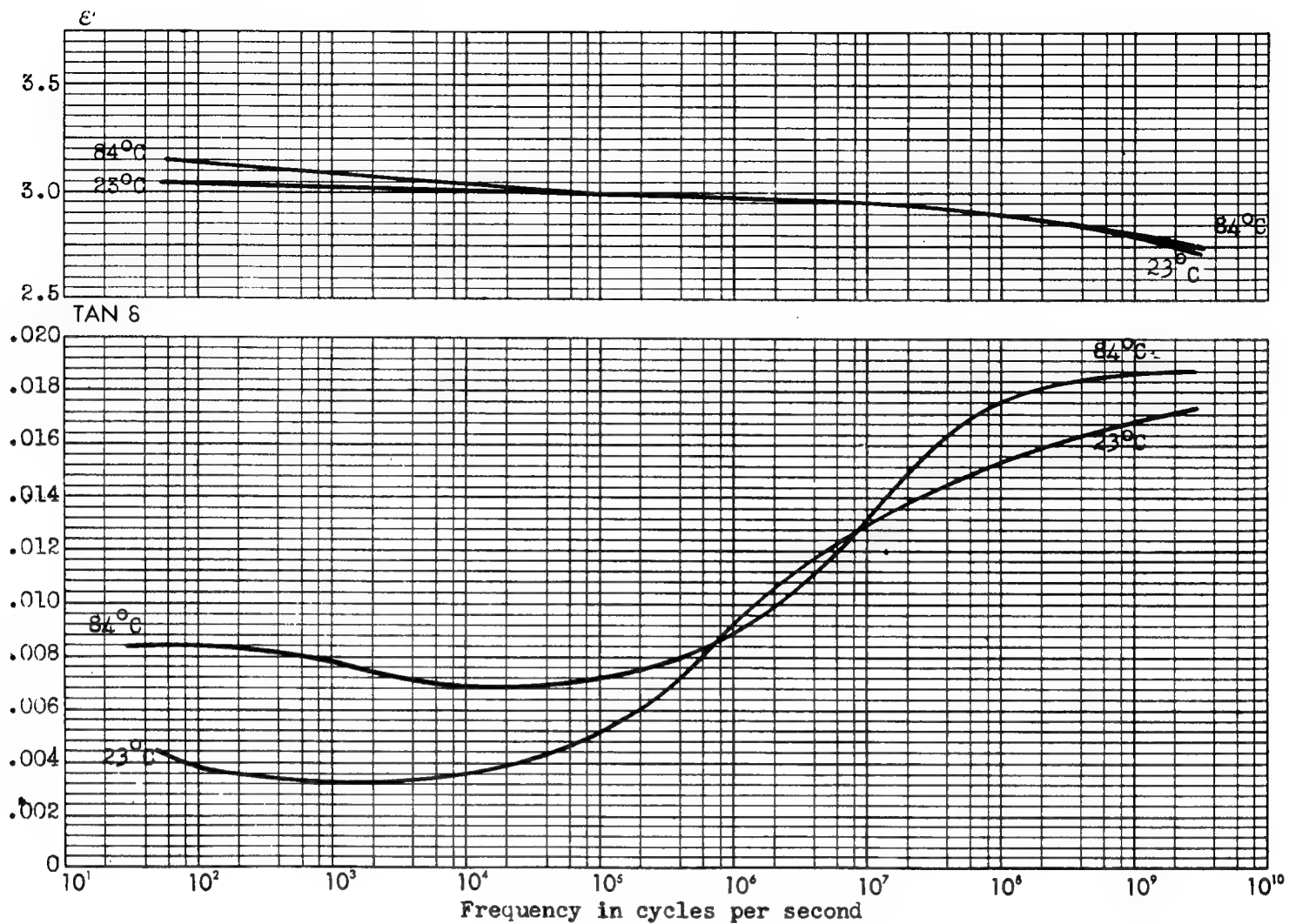
Chemical Name: Ethyl cellulose plastic Sample Designation: 1R-107-MH

Properties: Clear, slight blue tint.  $d_{25}^{25} = 1.15$ . Ten. Str. 9000. Rockwell y 82. Imp. (Izod): -40°C 0.4; 25°C 3.0; 80°C 3.6. Mod. El.  $4 \times 10^5$ . Comp. Str. 17,000. Shear. Str. 5000. Elong. 6.0%. Mach.: excellent. Spec. Heat 0.40. Therm. Exp.  $3.37 \times 10^{-4}$ . Therm. Cond.  $3.50 \times 10^{-4}$ .  $T_{dis}$  80°C.  $T_{soft}$  130°C. Therm. Sta. 70°C. Thermoplastic. Chem. Res.: weak acids, good; strong acids, poor; alkalies, good; alcohols, aromatic solvents, ketones and organic esters, poor; water, good; oxygen, good. Sun.: slight. Moist. Abs. 1.70%. Flam.: 1.40 in./min. Elec. Str. 1400 (10 mil). Surf. Res.  $2.95 \times 10^{13}$ . Arc Res.: excellent.

Methods of Handling: Inj. Mold. 220°C, 7000.

Recommended Uses: Radio cabinets, instrument covers, closures, cigarette boxes and other applications where appearance and hardness are desired.

Availability: Commercial quantities under allocation.



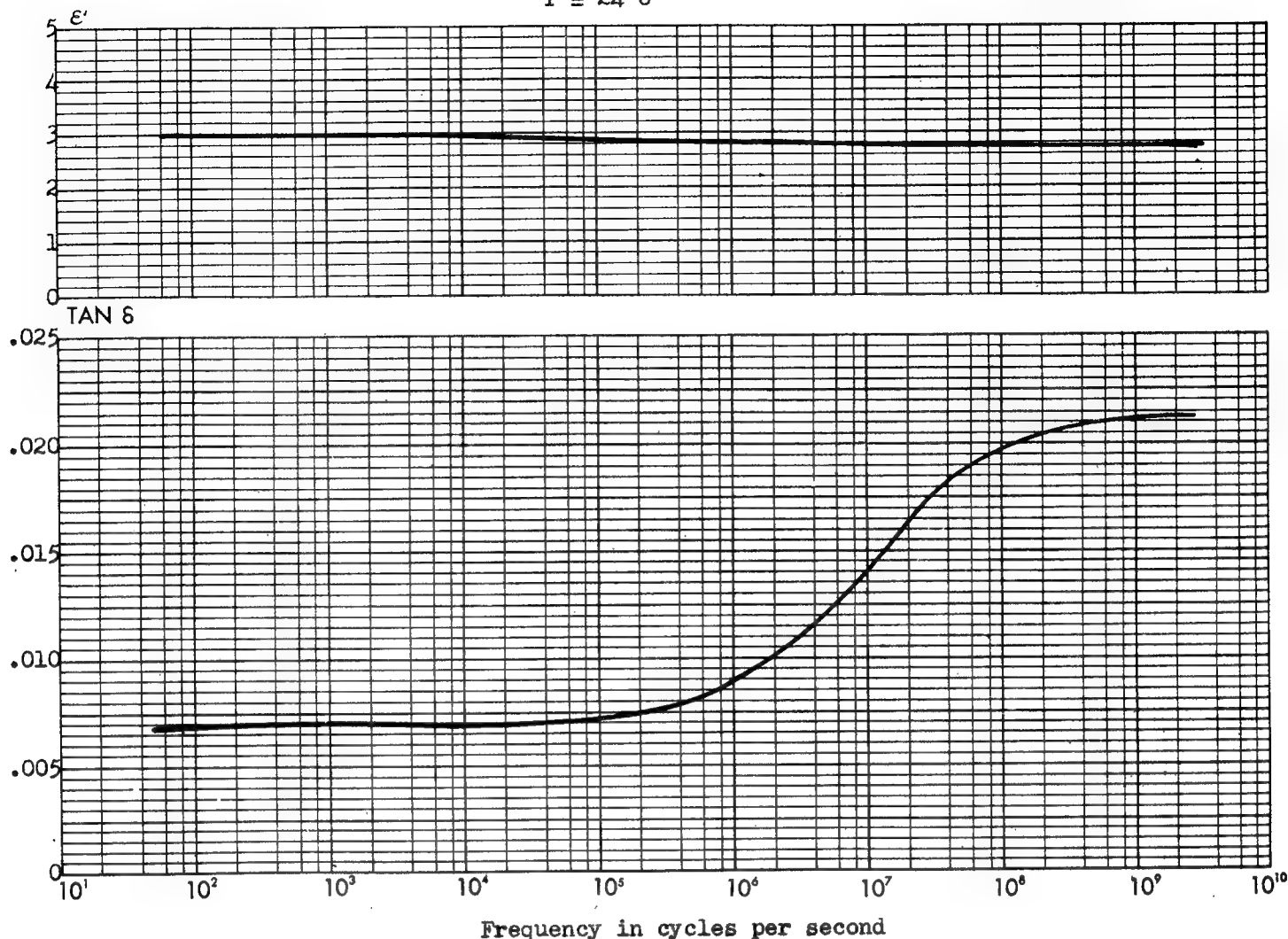
Chemical Name: Ethyl cellulose plastic.

Properties: Ten. Str. 8000. Imp.(Izod) 3.7 25°C.  $T_{dis}$  62°C. Moist. Abs. 3.03%.

Availability: By allocation



T = 24°C



Chemical Name: Ethyl cellulose plasticized.

Composition: Ethyl cellulose (87%), plasticizer (13%).

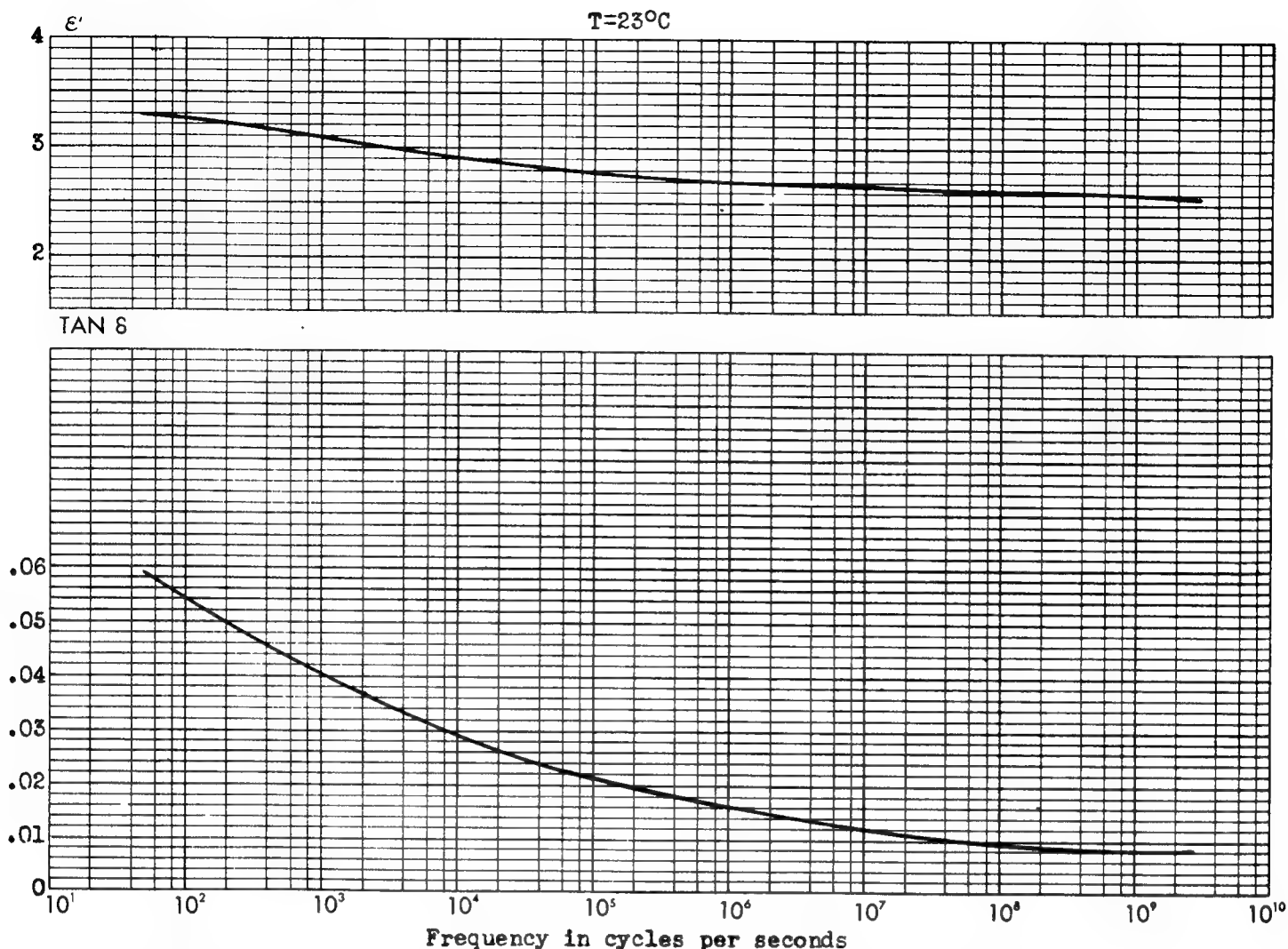
Properties: Transparent, translucent and opaque colors.  $d^{25}=1.09$ . Ten. Str. 6500. Brinell 5.18. Imp.(Izod):  $-40^{\circ}\text{C}$ , 1.6;  $25^{\circ}\text{C}$ , 8.6;  $80^{\circ}\text{C}$ , 10.5. Comp. Str.: yield 3800; ultimate 18,500. Flex. Str.  $25^{\circ}\text{C}$ , 5000. Elong. 9.0%. Mach.: good.  $T_{dis}$   $51^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids, good; alkalies, good; solvents, poor to most; water, good. Sun.: slight. Moist. Abs. 1.50%. Flam.: 2 in./min. Elec. Str. 522 (0.125" thick). Arc Res. 185.

Methods of Handling: Compr. Mold.  $149-182^{\circ}\text{C}$ , 1500-5000; Inj. Mold.  $188-243^{\circ}\text{C}$ , 3000-30,000. Extr.  $149-204^{\circ}\text{C}$ .

Recommended Uses: For molded parts which require toughness and high impact strength over wide temperature range with good dimensional and form stability at high humidities.

Availability: Molding powder in production quantity under allocation.





Chemical Name: Polymethyl methacrylate    Sample Designation: Lot 9271

Composition: Linear addition polymer of methyl methacrylate (practically 100%).

Properties: Colorless.  $d_{25}^{25}=1.17$ . Ten. Str. 7000-9000. Rockwell M80.

Imp.(Izod):  $25^{\circ}\text{C}$ , 0.2-0.4. Mod. El. 400,000. Flex. Str.  $25^{\circ}\text{C}$ , 15,000. Elong. 1%.

Mach.: good. Spec. Heat 0.35. Therm. Exp.  $11-14 \times 10^{-5}$ . Therm. Cond.  $6.00 \times 10^{-4}$ .

$T_{dis}$   $64^{\circ}\text{C}$ . Def. Load 20%. Thermoplastic. Chem. Res.: acids, good; alkalies, good; solvents, not resistant to esters, ketones, aromatics and chlorinated hydrocarbons;

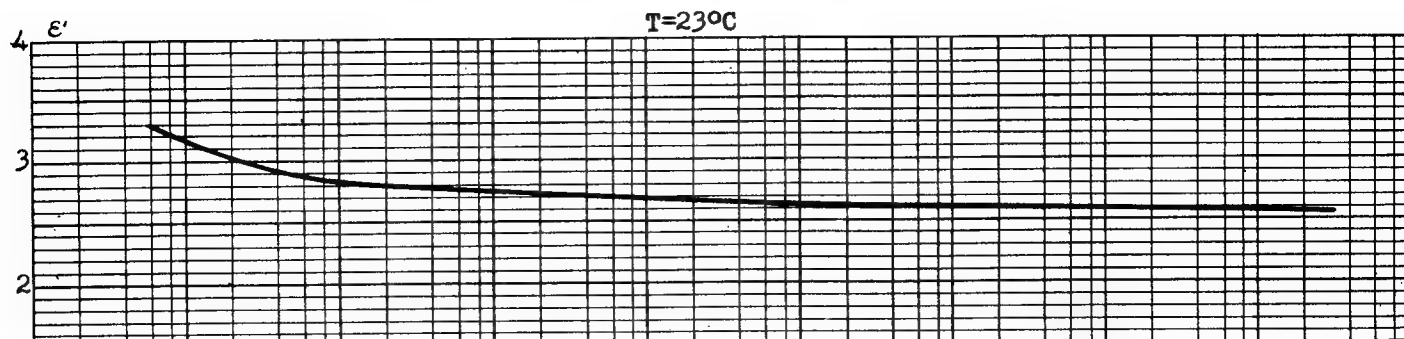
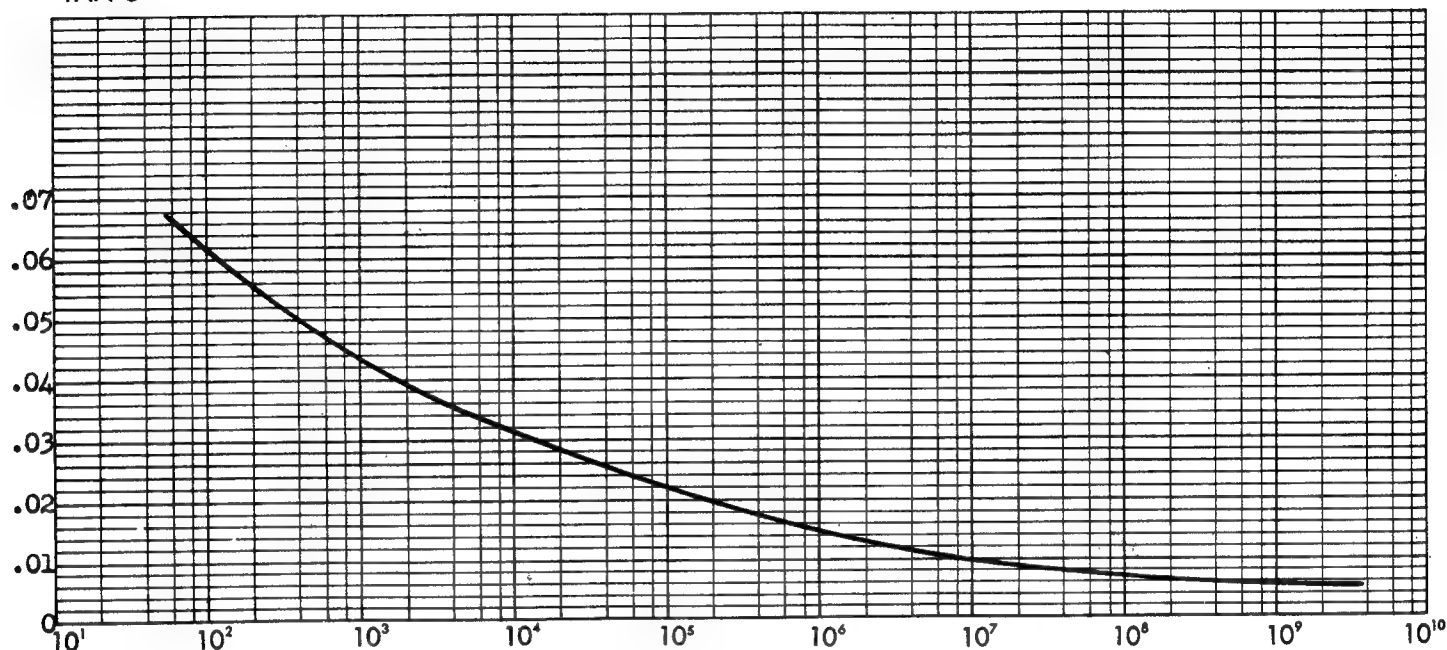
water, good. Sun.: practically nil. Moist. Abs. 0.4%. Flam.: burns slowly.

Elec. Str. 500 short time; 450 step-by-step. Arc Res.: non-tracking.  $n_D=1.50$ .

Methods of Handling: Compr. Mold.  $180-240^{\circ}\text{C}$ , 2000-3000; Inj. Mold.  $180-240^{\circ}\text{C}$ , 18,000-25,000. Extr.  $180-240^{\circ}\text{C}$ .

Recommended Uses: General molding; lens, knobs, fittings, coil forms, rigid insulation.

Availability: Molding powder in production quantities.

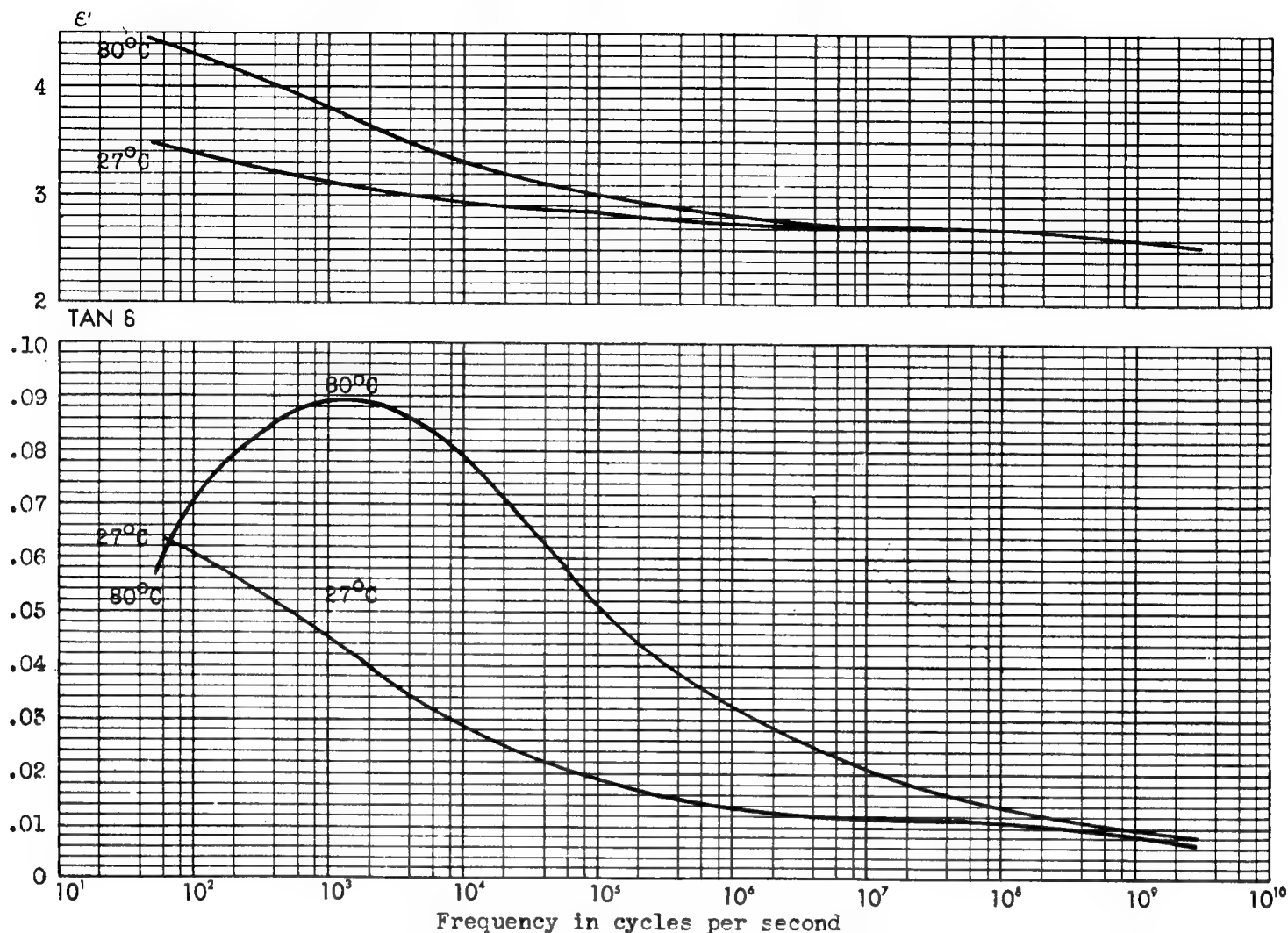
TAN  $\delta$ 

Frequency in cycles per second

Chemical Name: Polymethyl methacrylate Sample Designation: Lot 9189Composition: Linear addition polymer of methyl methacrylate (practically 100%).

Properties: Colorless, clear.  $d_{25}^{25}=1.19$ . Ten. Str. 7000, 25°C; 2900, 77°C. Rockwell M100. Imp.(Izod) 0.3, 25°C. Mod. El.  $4.0 \times 10^5$ . Flex. Str. 15,000 25°C. Elong. 1% 25°C; 49% 77°C. Spec. Heat 0.35. Therm. Exp.  $11-14 \times 10^{-5}$ . Therm. Cond.  $4.85-6.9 \times 10^{-4}$ .  $T_{dis}$  72°C. Thermoplastic. Chem. Res.: weak acids, good; alkalis, good; solvents, not resistant to esters, ketones, aromatics, chlorinated hydrocarbons; water, good; oxygen, good. Sun.: very slight effect. Moist. Abs. 0.4%. Flam.: very slow.  $n_D=1.49$ .

Methods of Handling: Inj. Mold. 216-227°C, 15,000.Recommended Uses: Heat resistant parts of all kinds.Availability: Molding powder in production quantity.



**Chemical Name:** Methacrylate resin.

**Composition:** Linear addition copolymer. **Chemicals used:** acetone, ethylene, sodium cyanide and chlorine.

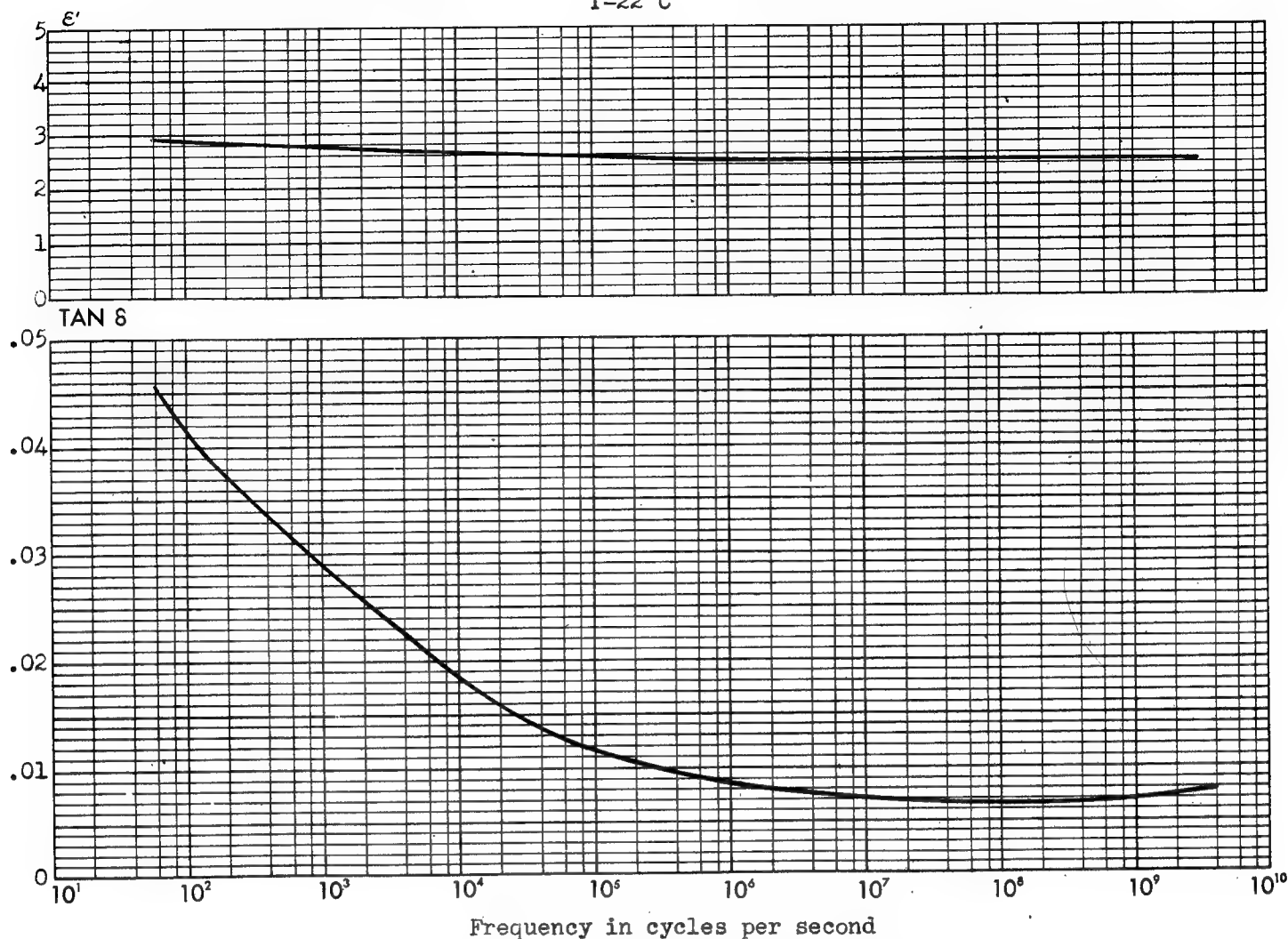
**Properties:** Colorless transparent or colored.  $d_{25}^{25}=1.85\pm 0.005$ . Ten. Str.: 5800-8000 C.S.\*, 4000-6000 I.M.\* & C.M.\*. Rockwell M70. Imp. (Charpy unnotched):  $-40^\circ\text{C}$  3.5 C.S., 3.5-4.5 I.M.;  $25^\circ\text{C}$  3.3 C.S., 4.0-4.5 I.M., 3-5 C.M. Mod. El.  $3-5\times 10^{-5}$  C.S.,  $3-6\times 10^{-5}$  I.M. & C.M. Comp. Str.: 11,000-13,000 C.S., 10,000-15,000 I.M. & C.M. Shear Str. 5000-7000 C.S. Flex. Str.:  $-40^\circ\text{C}$  21,000 C.S.;  $25^\circ\text{C}$  14,000 C.S., 10-11,000 I.M. & C.M. Elong.: in tension 2% C.S., 1-5% I.M. & C.M. Mach.: excellent. Spec. Heat 0.35. Therm. Exp.  $8\times 10^{-5}$  C.S.,  $8-9\times 10^{-5}$  I.M. & C.M. Therm. Cond.  $4.48-4.82\times 10^{-4}$ .  $T_{dis}$   $54-68^\circ\text{C}$  I.M.,  $70-75^\circ\text{C}$  C.M. Therm. Sta.:  $54-60^\circ\text{C}$  I.M.,  $71^\circ\text{C}$  C.M. Thermoplastic. Chem. Res.: oxidizing acids, poor; alkalis, excellent; organic solvents, poor; water, excellent; oxygen, excellent. Sun.: practically none. Moist. Abs. 0.3-0.6%. Flam.: 1.0-1.2. Elec. Str. 400-500. Arc Res.: excellent.  $n_D=1.488-1.489$ .

\*C.S.=Cast Sheet; I.M.=Injection Molded; C.M.=Compression Molded.

**Methods of Handling:** Compr. Mold.  $154-177^\circ\text{C}$ , 100-300. Inj. Mold.  $177-260^\circ\text{C}$ , medium to high pressure. Extrusion possible.

**Recommended Uses:** For outdoor electrical applications; for radar housings on planes and ships, insulators and panels. Also indicated where good appearance is a factor.

**Availability:** Second grade material and pieces under 3 sq. ft. unrestricted. First grade and larger sizes subject to allocation. Various sheet sizes and thicknesses. Compression and injection molding powders.



Chemical Name: Polyethyl methacrylate Sample Designation: Sample No. A-3159

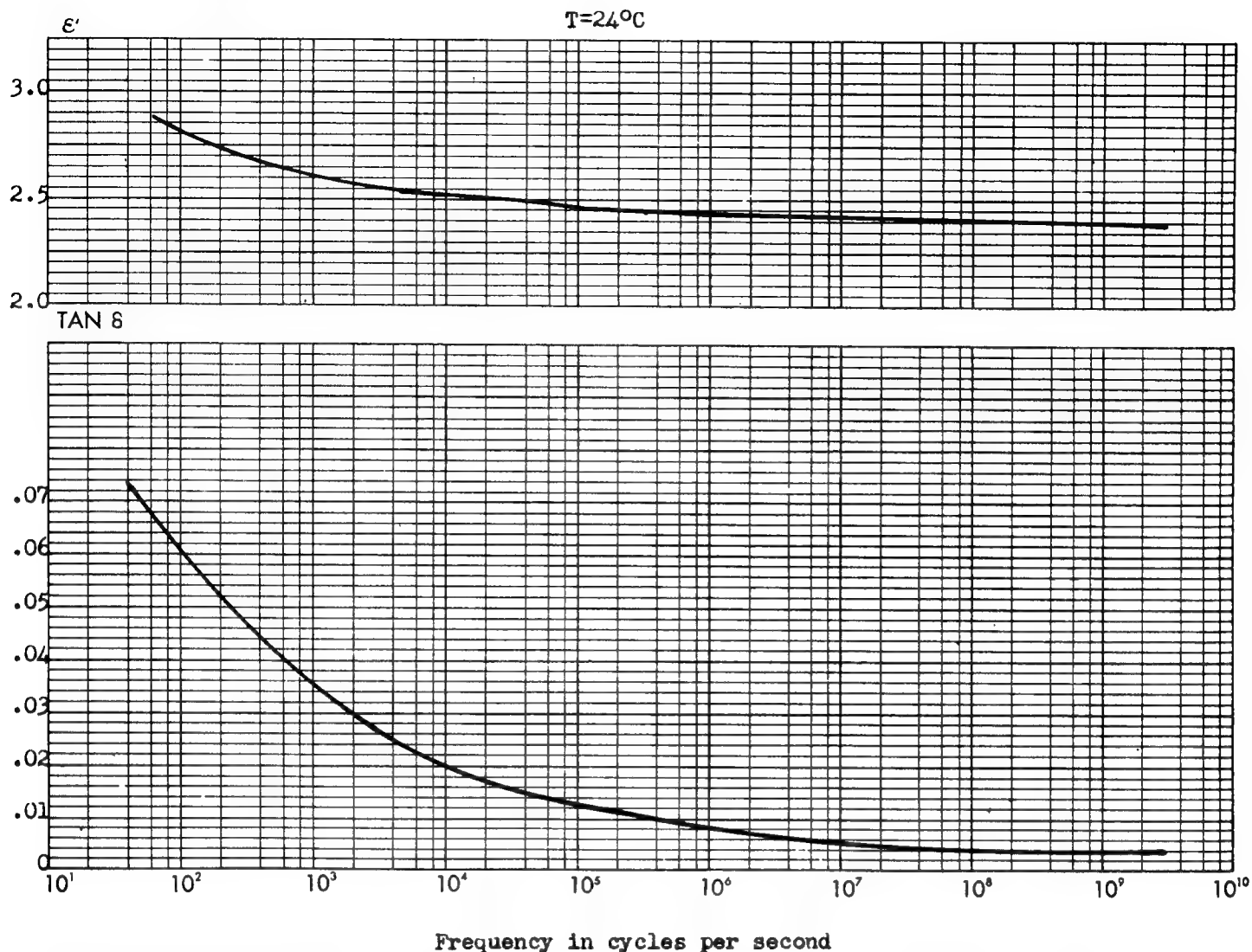
Composition: Linear addition polymer of ethyl methacrylate (100%).

Properties: Clear, colorless.  $d_{25}^{25}=1.11$ . Ten. Str. 5000. Elong. 7%. Mach.: good.  $T_{dis}$  60°C. Thermoplastic. Chem. Res.: acids, excellent; alkalies, excellent; most solvents, poor; water, very good; oxygen, good. Sun.: none. Moist. Abs.: low. Flam.: moderate.  $n_D=1.485$ .

Methods of Handling: Cast.: from monomer, 25-60°C for one to several days. Compr. Mold. 110-140°C, 1000-2000. Extrusion possible. Lacquer: baking improves adhesion, temp. up to 200°C; solvent, aromatic hydrocarbons and esters.

Recommended Uses: General plastic applications, lacquers, adhesives, etc.

Availability: Granular polymer in production quantities under allocation.



Chemical Name: Polybutyl methacrylate. Sample Designation: Sample No. A-3160

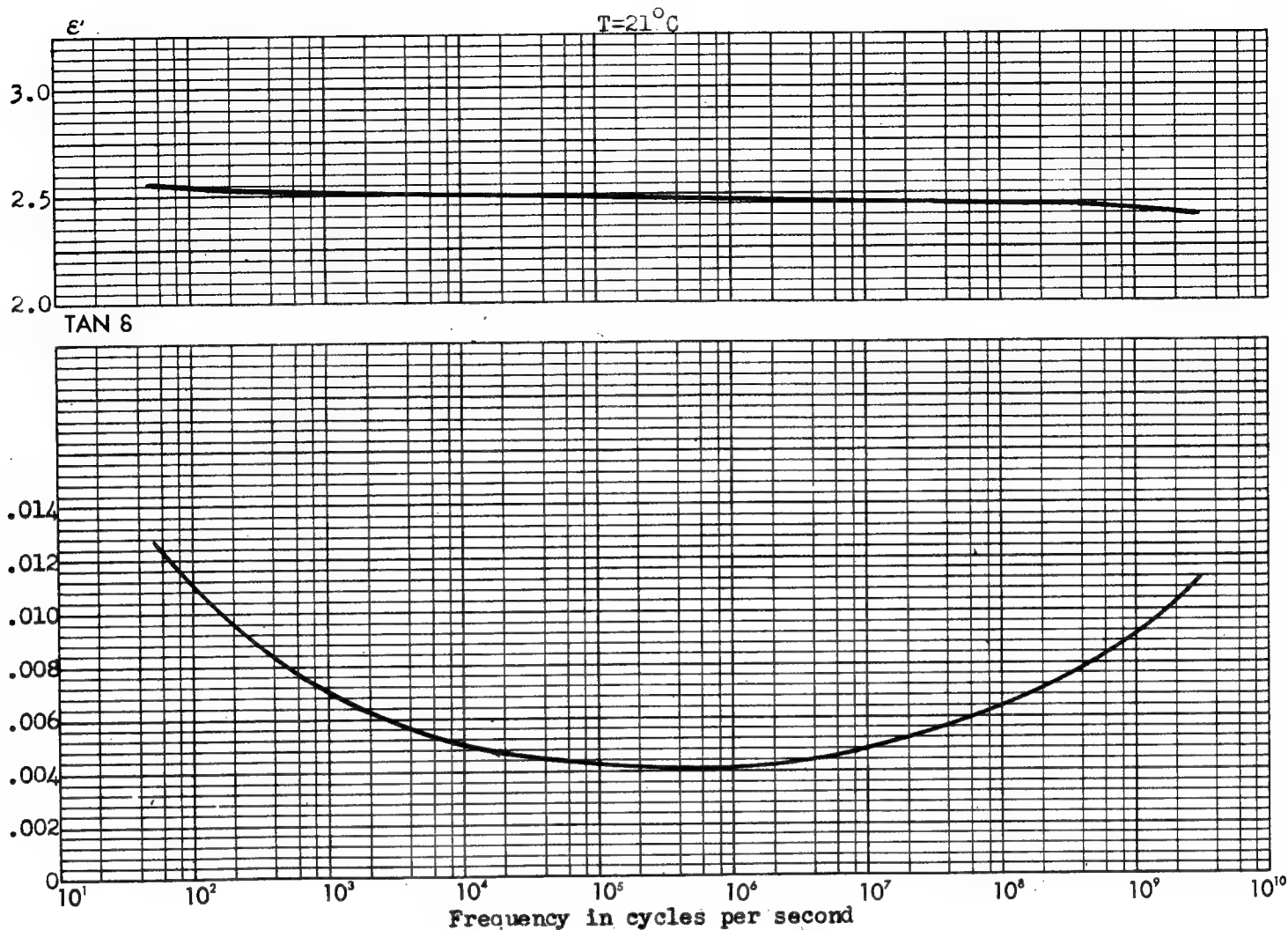
Composition: Linear addition polymer of butyl methacrylate (100%).

Properties: Clear, colorless.  $d^{25}_4=1.05$ . Ten. Str. 1000. Elong. 200% Mach.: poor.  $T_{dis}$ : flexible at room temperature. Therm. Sta.: good. Thermoplastic. Chem. Res.: acids, excellent; alkalies, excellent; solvents, dissolves in most; water, good; oxygen, good. Sun.: none. Moist. Abs.: low. Flam.: moderate.  $n_D=1.483$ .

Methods of Handling: Cast.: from monomer, temp. and time depend on article being fabricated. Compr. Mold.  $90-120^{\circ}\text{C}$ , 1000-2000. Extrusion possible. Lacquer: baking improves adhesion, temp. up to  $200^{\circ}\text{C}$ ; solvent, aromatic and aliphatic hydrocarbons, esters, etc.

Recommended Uses: General plastic applications, lacquers, leather finishes, adhesives, etc.

Availability: Granular polymer in production quantities under allocation.



Chemical Name: Polyisobutyl methacrylate. Sample Designation: Sample No. A-3161

Composition: Linear addition polymer of isobutyl methacrylate (100%).

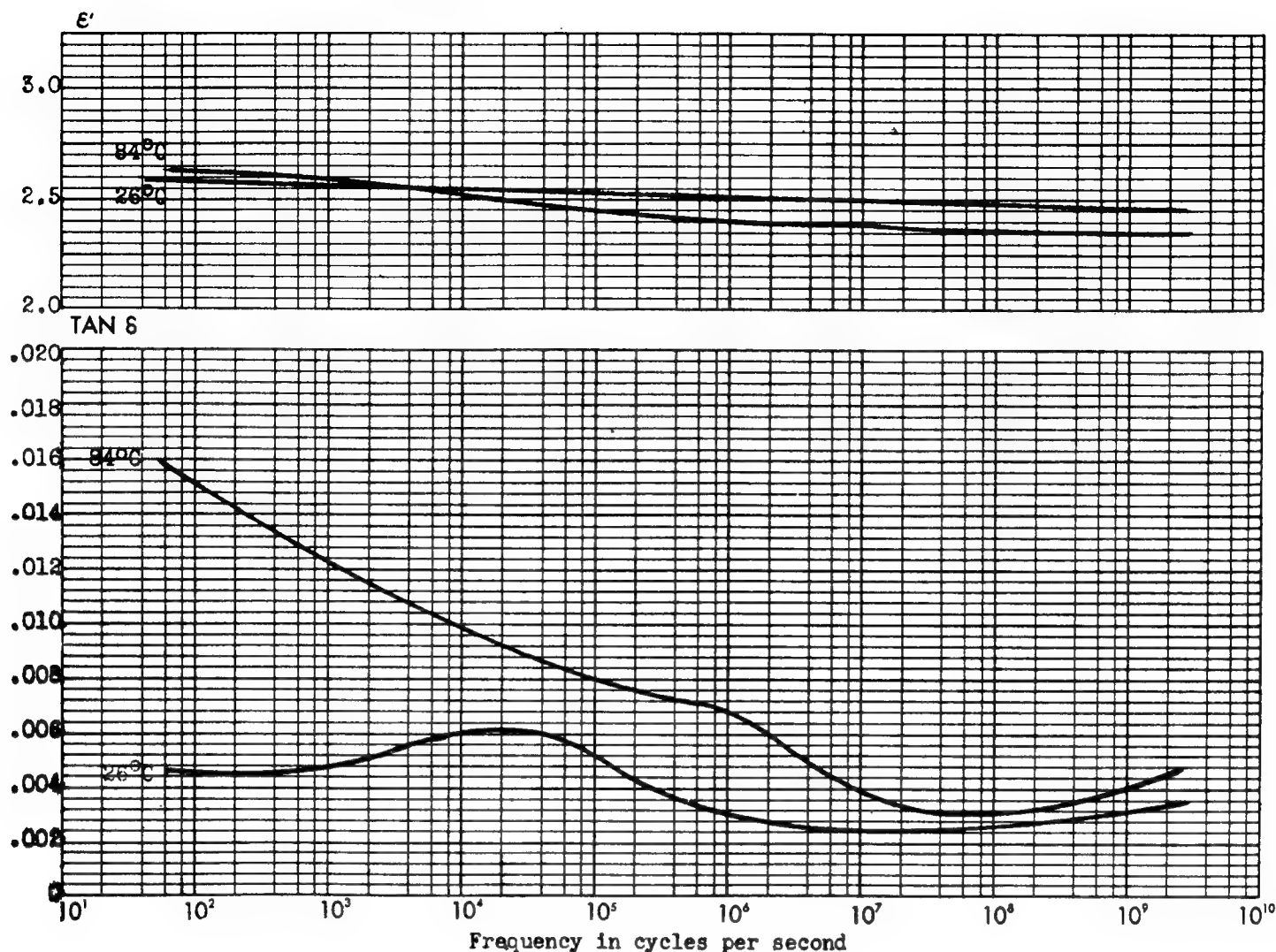
Properties: Clear, colorless.  $d_{25}^{25}=1.02$ . Ten. Str. 3000. Elong. 2-3%. Mach.: fair. T<sub>dis</sub> 50°C. Therm. Sta.: good. Thermoplastic. Chem. Res.: acids, excellent; alkalis, excellent; solvents, dissolved by most solvents; water, good; oxygen, good. Sun.: none. Moist. Abs.: low. Flam.: moderate.  $n_D=1.477$ .

Methods of Handling: Cast.: from monomer, temp. and time depend on article being fabricated. Compr. Mold. 110-140°C, 1000-2000. Extrusion possible. Lacquer: baking improves adhesion, temp. up to 200°C; solvent, aromatic and aliphatic hydrocarbons, esters, etc.

Recommended Uses: General plastic applications, lacquers, leather finishes, adhesives, etc.

Availability: Granular polymer in production quantities under allocation.





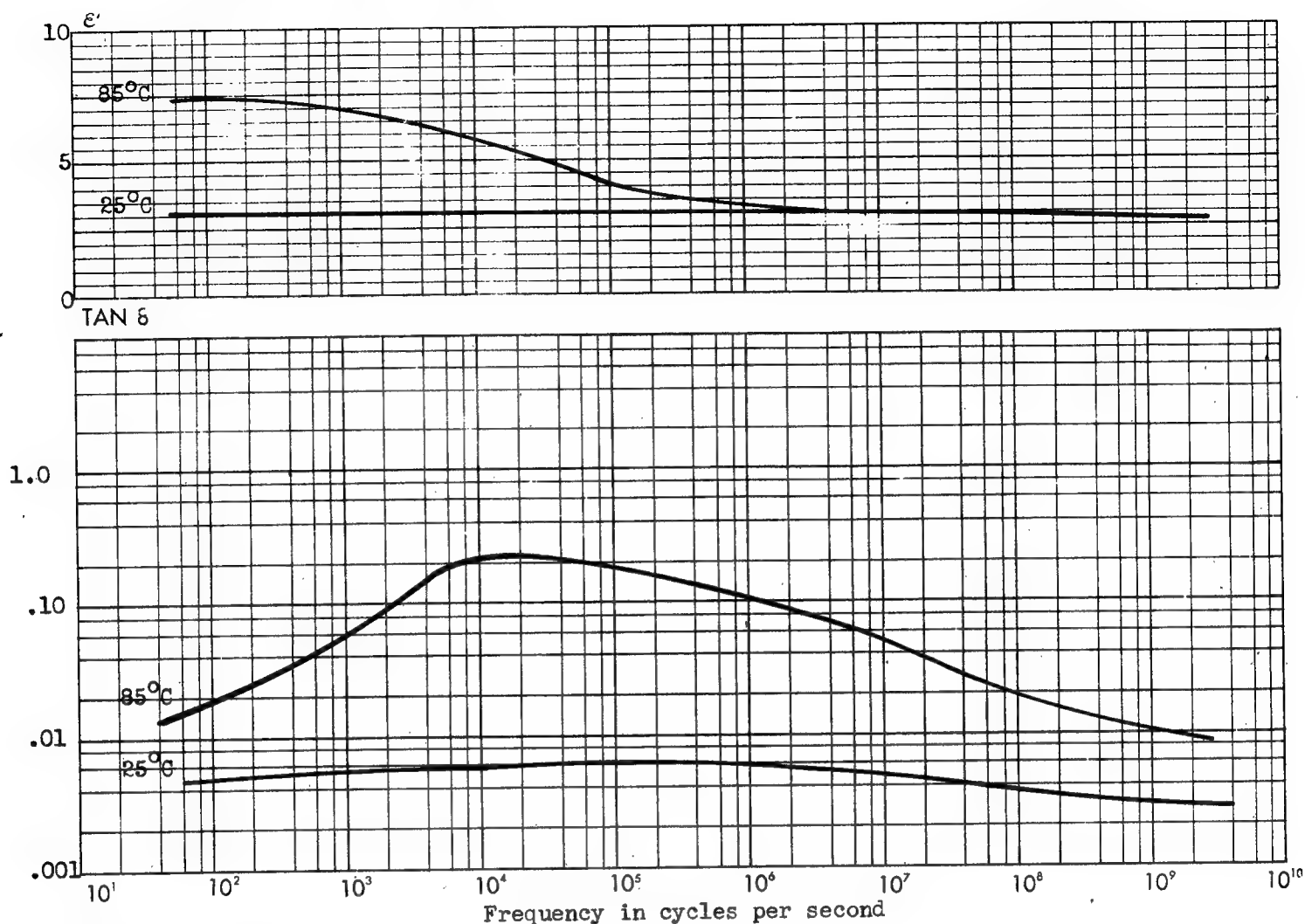
Composition: Linear addition polymer of cyclo hexyl methacrylate (100%).

Properties: Clear, haze-free.  $d_{26}^{26}=1.0951-1.0972$ . Rockwell H60. Mach.: good. Therm. Exp.  $8.7 \times 10^{-5}$ .  $T_{\text{soft}} 70^\circ\text{C}$ . Therm. Sta.  $68^\circ\text{C}$ . Thermoplastic. Chem. Res.: acids, excellent except  $\text{H}_2\text{SO}_4$  and  $\text{HNO}_3$ ; alkalies, excellent; most organic solvents, poor; water, excellent; oxygen, excellent. Sun.: no effect. Moist. Abs. 0.17% in 1 hr. in boiling water. Flam.: slow.  $n_D = 1.506$ .

Methods of Handling: Cast.  $80^\circ\text{C}$  max., time and temp. cycle depends on mass and shape.

Recommended Uses: Optical elements requiring high homogeneity and dimensional stability.

Availability: In production for military purposes.



**Chemical Name:** Polyvinyl acetate

**Sample Designation:** RH-411 methanol solution, RH-460A water emulsion, RH-838 solid.

**Composition:** Linear addition polymer of vinyl acetate plus catalysts.

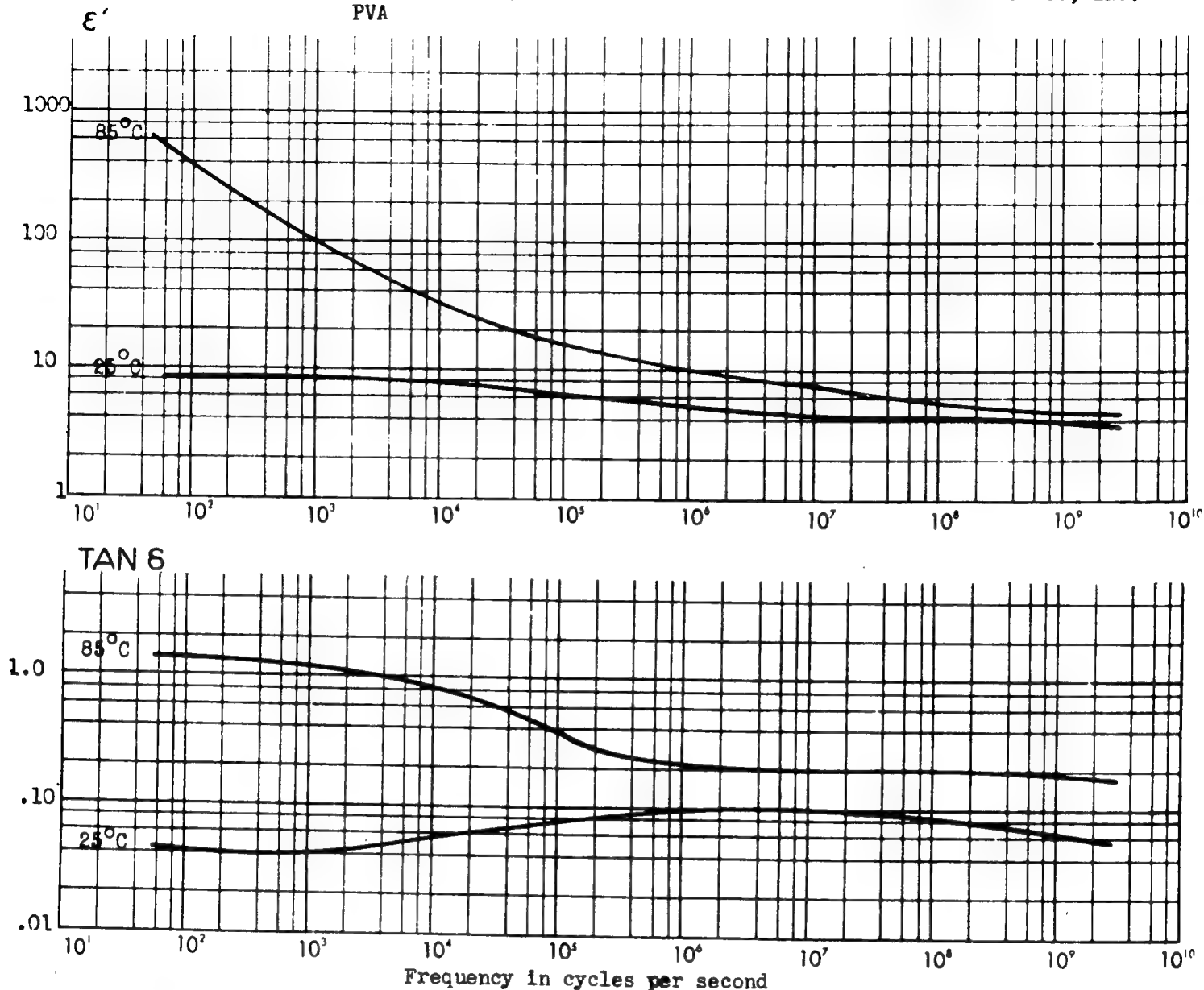
**Properties:** RH-411 & RH-838 glass clear; RH-460A water-white, cloudy.  $d_{20}^{20}=1.19$ .  
**Rockwell:** for RH-838, L84. **Therm. Exp., cubical:** RH-838  $22 \times 10^{-5}$  0-25°C;  
 $73 \times 10^{-5}$  30-100°C. **Sealing Temp.:** RH-411 70-80°C; RH-460A 120-130°C; RH-838 120-125°C.  
**T<sub>soft</sub>:** RH-411 95-105°C; RH-460A decomposes; RH-838 decomposes above 250°C. **Therm. Sta.:**  
 RH-838 slight yellowing after 42 hrs. at 100°C, 17 hrs. at 125°C, 1 hr. at 150°C.  
**Thermoplastic.** **Chem. Res.:** acids, softens or soluble; alkalies, softens and swells;  
 solvents, resistant to oils and petroleum hydrocarbons; soluble in lower alcohols,  
 ketones, esters, aromatic and chlorinated hydrocarbons; water, RH-411 & RH-838 soften  
 and whiten, RH-460A films whiten and disintegrate; oxygen, excellent. **Sun.:** unaffected.  
**Moist. Abs.:** low. **Flam.:** slow.

**Methods of Handling:** Lacquer: dry to evaporate solvent at 50°C for RH-411,  
 to near water boil for RH-460A, 180°C for RH-838; solvents, lower alcohols, ketones,  
 esters, aromatic hydrocarbons and chlorinated hydrocarbons.

**Recommended Uses:** Primarily for hot melt and solvent-activated adhesives for practically  
 all materials, organic and inorganic, except rubber. RH-460A is an effective substitute  
 for rubber latex emulsion in many applications such as adhesives, paper pulp, ceramic  
 mixture, leather scrap binders.

**Availability:** Molding powder in production quantity under allocation.





**Chemical Name:** Partially hydrolyzed polyvinyl acetate.

**Composition:** Linear addition polymer of vinyl acetate plus catalysts.

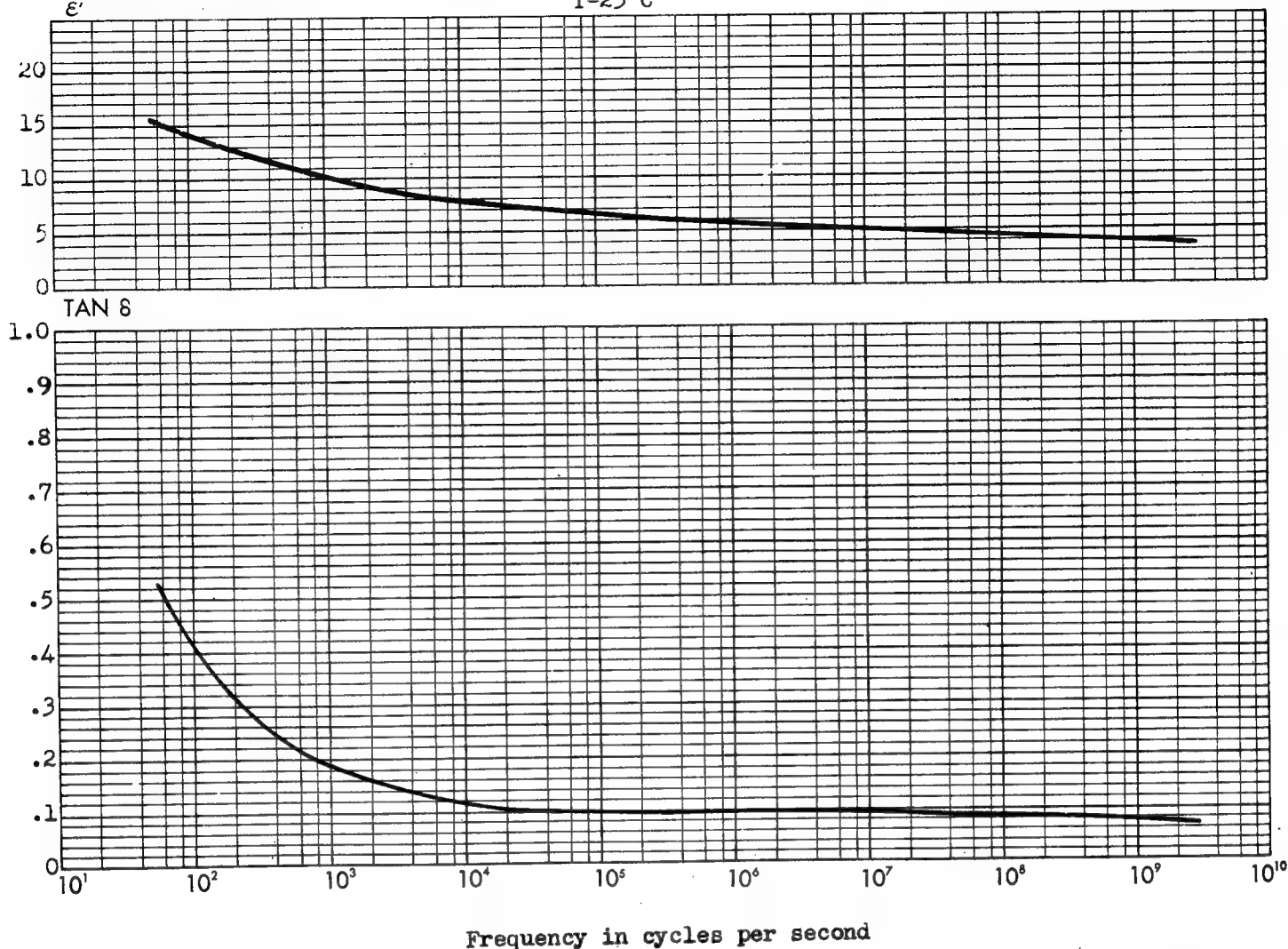
**Properties:** White to cream-colored powder.  $d^{20}_D=1.27$ . Ten. Str.: film plasticized with 10% glycerol, 10,000-15,000; unplasticized molding, 5000. Shore >100 unplasticized. Therm. Sta.: darkens slowly above 100°C, rapidly above 150°C; decomposes above 200°C. Thermoplastic. Chem. Res.: acids, poor; alkalies, poor; solvents, excellent; cold or hot water, poor; oxygen, excellent. Sun.: unaffected. Flam.: slow.  $n_D=1.52$ .

**Methods of Handling:** Compr. Mold.: unplasticized about 165°C, plasticized 140-150°C; 500-1000. Extr. plasticized about 100°C. Lacquer: air dry to evaporate solvent at 25-100°C; solvent, water; thinner, water and lower alcohols.

**Recommended Uses:** Textile sizing; casting or extruding water-soluble film, sheet tubing, etc. with high solvent resistance; base for preparation of adhesives; stabilizer for aqueous dispersions, thickener for aqueous solutions; binder in aqueous coating compositions.

**Availability:** Molding powder in production quantity under allocation.

T=23°C



Chemical Name: Partially hydrolyzed polyvinyl acetate. Sample Designation: RH-403

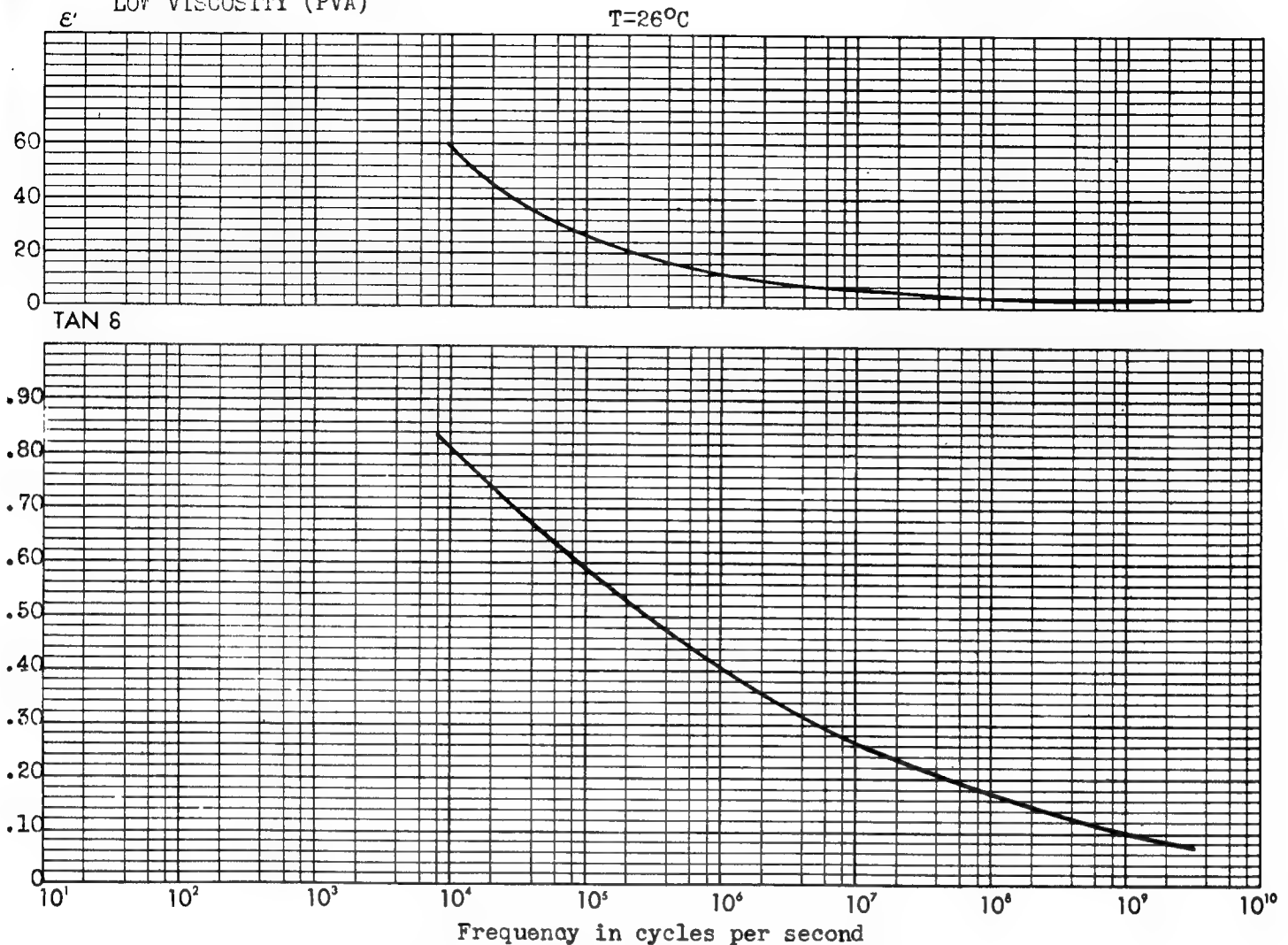
Composition: Linear addition polymer of vinyl acetate plus catalysts.

Properties: White to cream powder.  $d_{20}^{20}=1.27$ . Ten. Str.: unplasticized film, 22,000-24,000; unplasticized molding, 6000. Shore: unplasticized 100. Elong.: unplasticized film <10%. Therm. Sta.: darkens slowly above 100°C; rapidly above 150°C; decomposes above 200°C. Thermoplastic. Chem. Res.: acids, soluble; alkalis, soluble; solvents, excellent; water, soluble; oxygen, excellent. Sun.: unaffected. Moist Abs.: dissolves in cold or hot water. Flam.: slow.  $n_D=1.52$ .

Methods of Handling: Compr. Mold.: unplasticized about 165°C, plasticized 140-150°C; 500-1000. Extr.: plasticized about 100°C. Lacquer: air dry to evaporate water at 25°C to near 100°C; solvent, water; thinner, water and lower alcohols.

Recommended Uses: Remoistenable adhesive coatings on paper, fabrics, etc. Emulsifying oils, fats, waxes. Thickener for aqueous adhesives and dispersions in general. Coating, extruding, molding greaseproof water-soluble films, sheets, tubing, etc.

Availability: Molding powder in production quantity under allocation.



Chemical Name: Polyvinyl alcohol. Sample Designation: RH-393

Composition: Linear addition polymer of vinyl acetate plus catalysts.

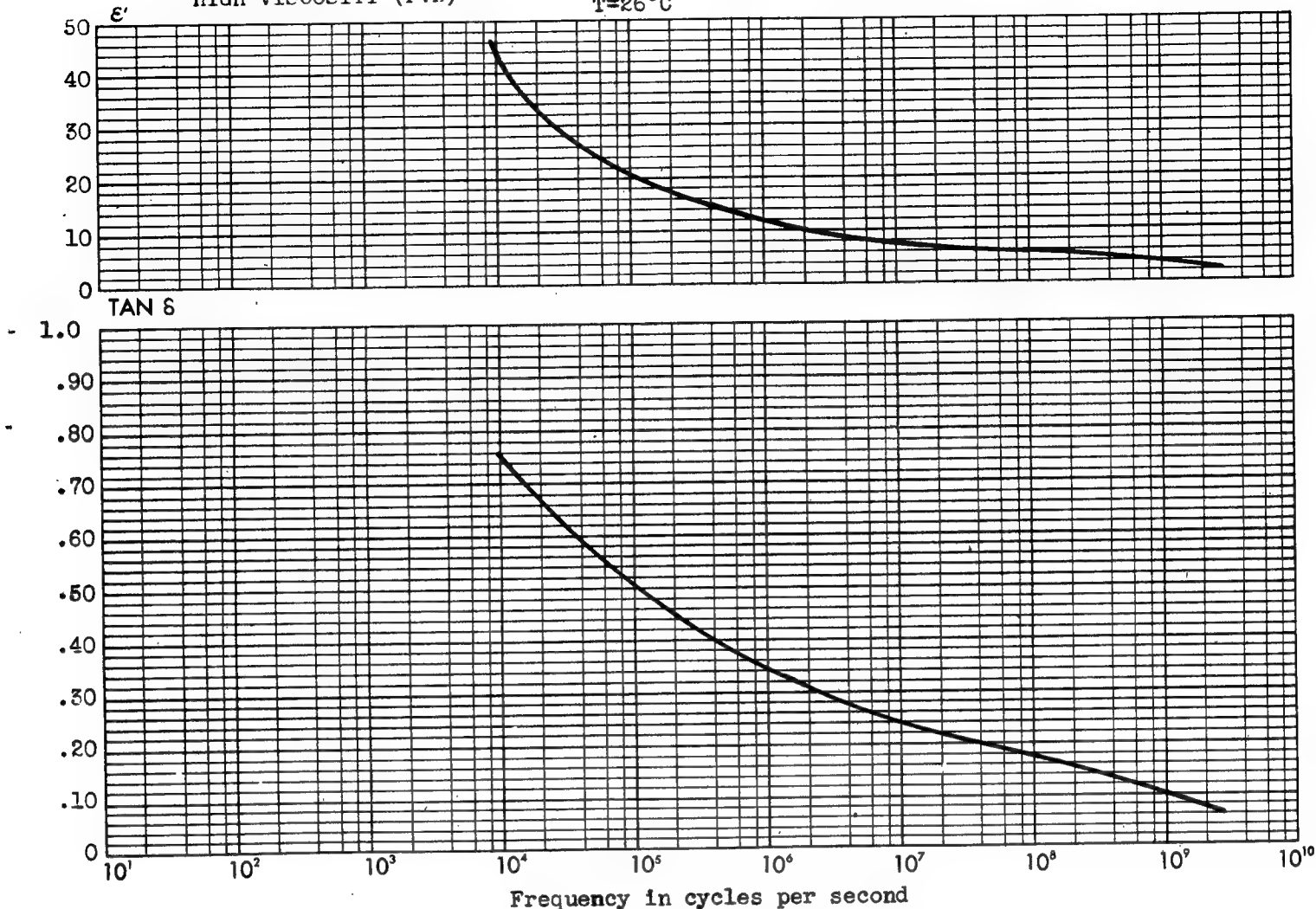
Properties: Cream-colored powder.  $d_{20}^{20}=1.3$ . Ten. Str.: Film - unplasticized, too brittle to measure; plasticized with 10% glycerol 10,000-15,000; Molding - unplasticized, 9000. Shore: unplasticized >100. Therm. Sta.: darkens slowly above  $100^{\circ}\text{C}$ ; rapidly above  $150^{\circ}\text{C}$ ; decomposes above  $200^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids, swells or dissolves; alkalies, swells; solvents, unaffected; water, swells  $25^{\circ}\text{C}$  and dissolves at  $65-85^{\circ}\text{C}$ ; oxygen, excellent. Sun.: unaffected. Moist. Abs. 100% at  $25^{\circ}\text{C}$ ; dissolves in hot water. Flam.: slow.  $n_D=1.53$ .

Methods of Handling: Compr. Mold.: unplasticized above  $165^{\circ}\text{C}$ , plasticized  $150-160^{\circ}\text{C}$ ; 500-1000. Extr.: plasticized about  $100^{\circ}\text{C}$ . Lacquer: air dry to evaporate solvent at  $25-100^{\circ}\text{C}$ ; solvent, water; thinner, water and lower alcohols.

Recommended Uses: Textile sizing; casting or extruding water-soluble film, sheet, tubing, etc. with high solvent resistance; base for preparation of adhesives; stabilizer for aqueous dispersions, thickener for aqueous solutions; binder in aqueous coating compositions. Greaseproofing paper and paper board, glassine, paper products in general.

Availability: Molding powder in production quantity under allocation.

T=26°C



**Chemical Name:** Polyvinyl alcohol. **Sample Designation:** RH-391N

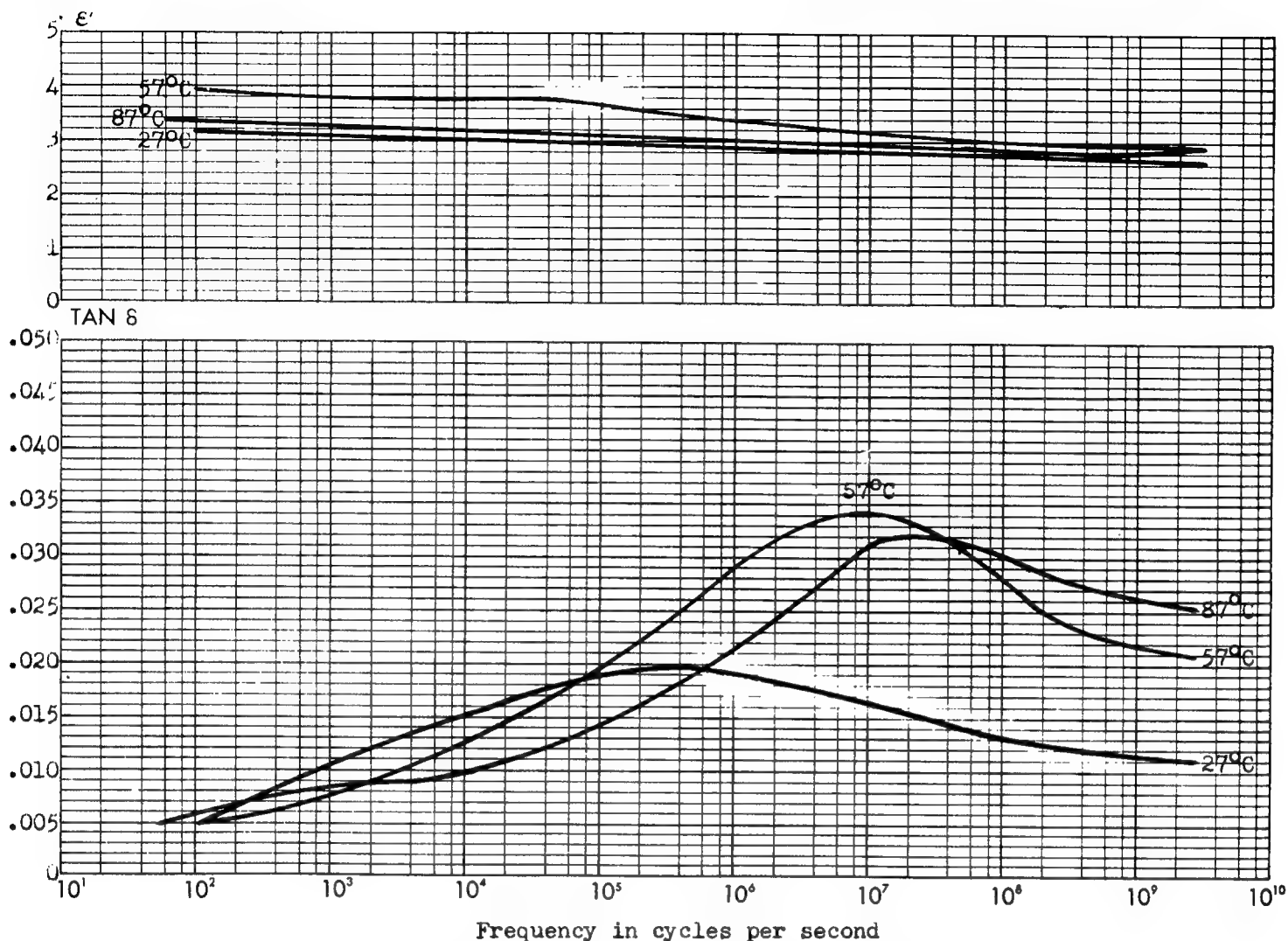
**Composition:** Linear addition polymer of vinyl acetate plus catalysts.

**Properties:** White to cream powder.  $d_{20}^{20}=1.3$ . Ten. Str.: unplasticized film 30,000-33,000; unplasticized molding 18,000. Shore: unplasticized >100. Elong: unplasticized film 10%; plasticized film up to 300%. Therm. Sta.: darkens slowly above 100°C; rapidly above 150°C; decomposes above 200°C. Thermoplastic. Chem. Res.: acids, swells or dissolves; alkalies, swells; solvents, unaffected; water, swells, dissolves on heating to 65-85°C; oxygen, excellent. Sun.: unaffected. Moist. Abs. 25°C: molding 100% in 7 days; film 100-200% in 30 min. Flam.: slow.  $n_D=1.53$ .

**Methods of Handling:** Compr. Mold.: unplasticized above 165°C, plasticized 150-160°C; 500-1000. Extr.: plasticized, about 100°C. Lacquer: air dry to evaporate solvent at 25-100°C; solvent, water; thinner, water and lower alcohols.

**Recommended Uses:** Solvent and grease proof coatings on paper, fabrics, leather, etc. Casting, extruding, molding solvent and grease resistant film, sheet, tubing, etc. Special emulsification applications. Base for aqueous adhesives and binder in aqueous coating compositions. Binder for foundry cores and ceramic mixtures.

**Availability:** Molding powder in production quantity under allocation.



Chemical Name: Polyvinyl formal Sample Designation: "Formvar 15/95 E Grade"

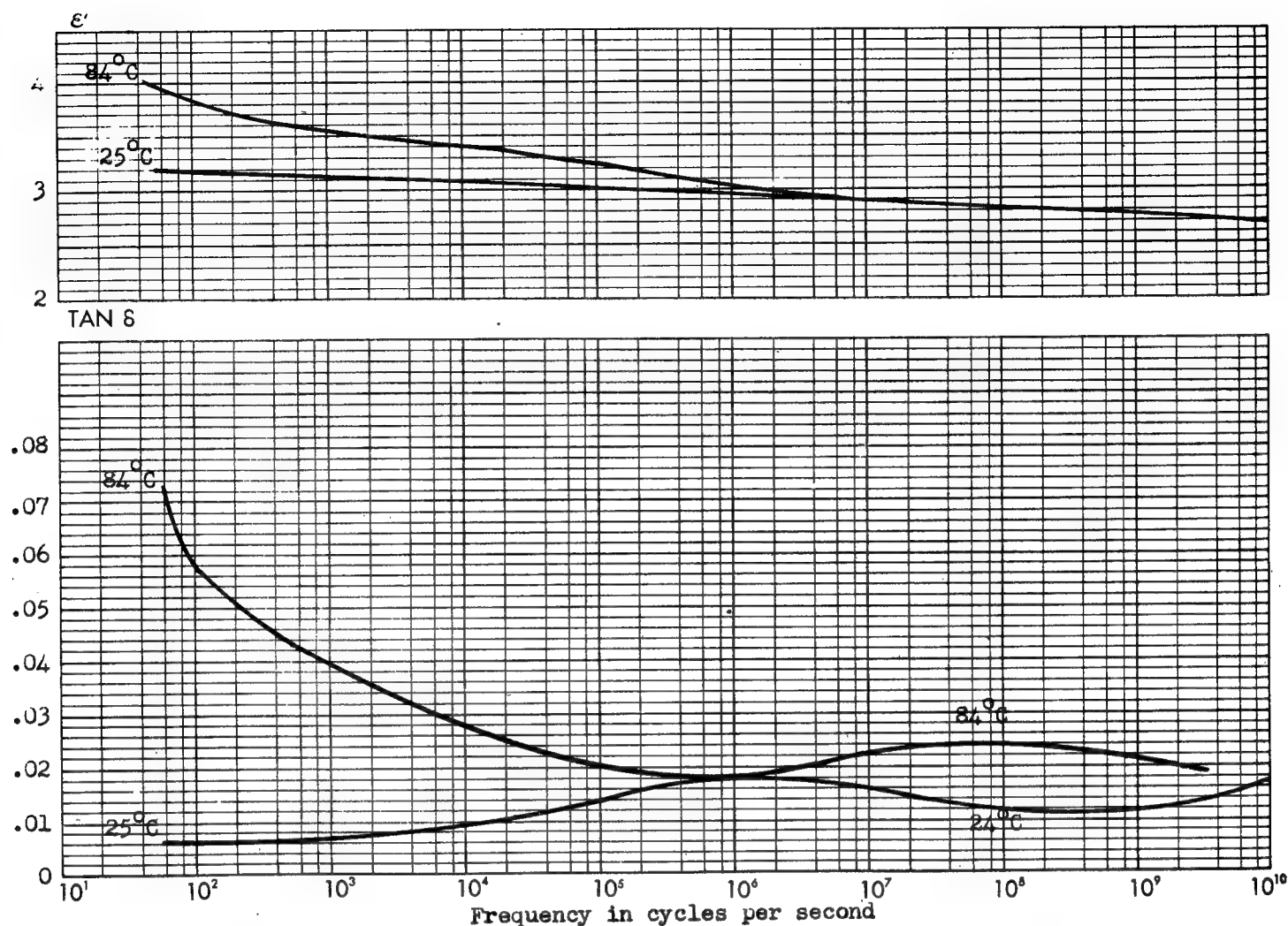
Composition: Linear addition polymer made from polyvinyl acetate and formaldehyde.

Properties: White to pale straw colored.  $d_{20}^{20}=1.2-1.3$ . Ten. Str. 10,000-12,000. Rockwell M80-M90. Mod. El.  $2.6 \times 10^5$ . Elong. 6-8%. Mach.: excellent. Therm. Exp.  $7.7 \times 10^{-5}$ . Therm. Cond.  $3.7 \times 10^{-4}$ .  $T_{dis}$  82-100°C.  $T_{soft}$  190°C. Therm. Sta. 150°C. Thermoplastic. Chem. Res.: acids, poor; alkalies, good; aliphatic hydrocarbons and vegetable oils, excellent; alcohols, ketones and aromatic hydrocarbons, fair; chlorinated solvents and dioxane, poor; water, slight clouding; oxygen, excellent at ordinary temps. Sun.: slight embrittlement and discoloration on long exposure. Moist. Abs. 1.3%. Flam.: low. Elec. Str. 1000.  $n_D=1.5$ .

Methods of Handling: Compr. Mold. 150°C, 2000.

Recommended Uses: Electrical insulation, surface coatings, special adhesives, plastic layer in laminated wood (airplane propellers), flexible sheeting, and molding compositions.

Availability: Molding powders in commercial quantities under allocation.



Chemical Name: Polyvinyl acetal.

Composition: Derivative of linear addition polymer made from partially hydrolyzed polyvinyl acetate and acetaldehyde.

Properties: Clear, light straw color.  $d_{25}^{25}=1.10$ . Ten. Str. 6000-9000. Spec. Heat 0.29. Therm. Exp.  $6.5 \times 10^{-5}$ . Therm. Cond.  $44 \times 10^{-5}$ .  $T_{dis}$  75-90°C.  $T_{soft}$  195°C. Therm. Sta. 150°C. Thermoplastic. Chem. Res.: mineral and vegetable oils, good; alcohols, ketones, esters, hydrocarbons and chlorinated hydrocarbons, poor; water, good. Sun.: slight. Moist. Abs. 2%. Flam.: low.

Methods of Handling: Compr. Mold. 125-150°C, 500-2000. Injection molding and extrusion possible.

Recommended Uses: Molded parts in electrical equipment, combs, buttons, shoe heels, etc.; adhesives; lacquers; impregnating dopes.

Availability: Production quantities under allocation.

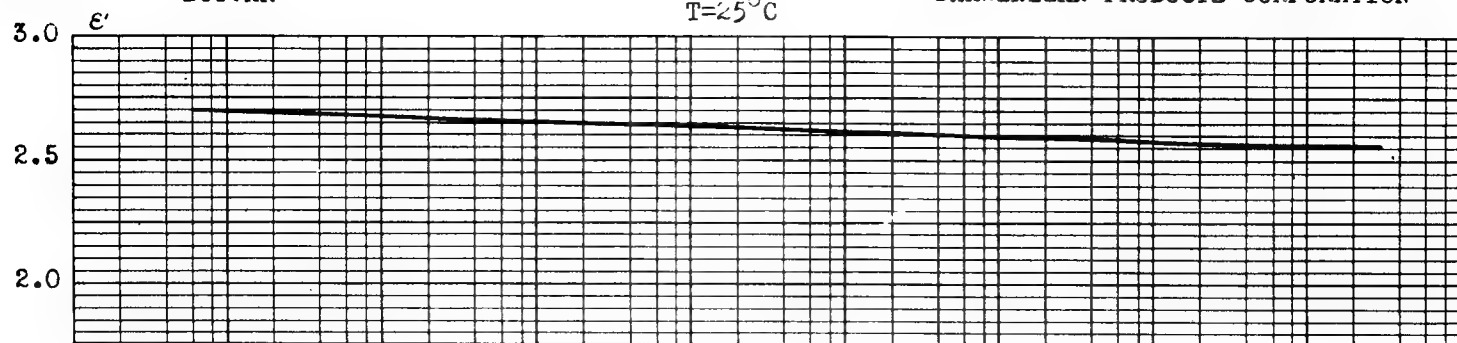
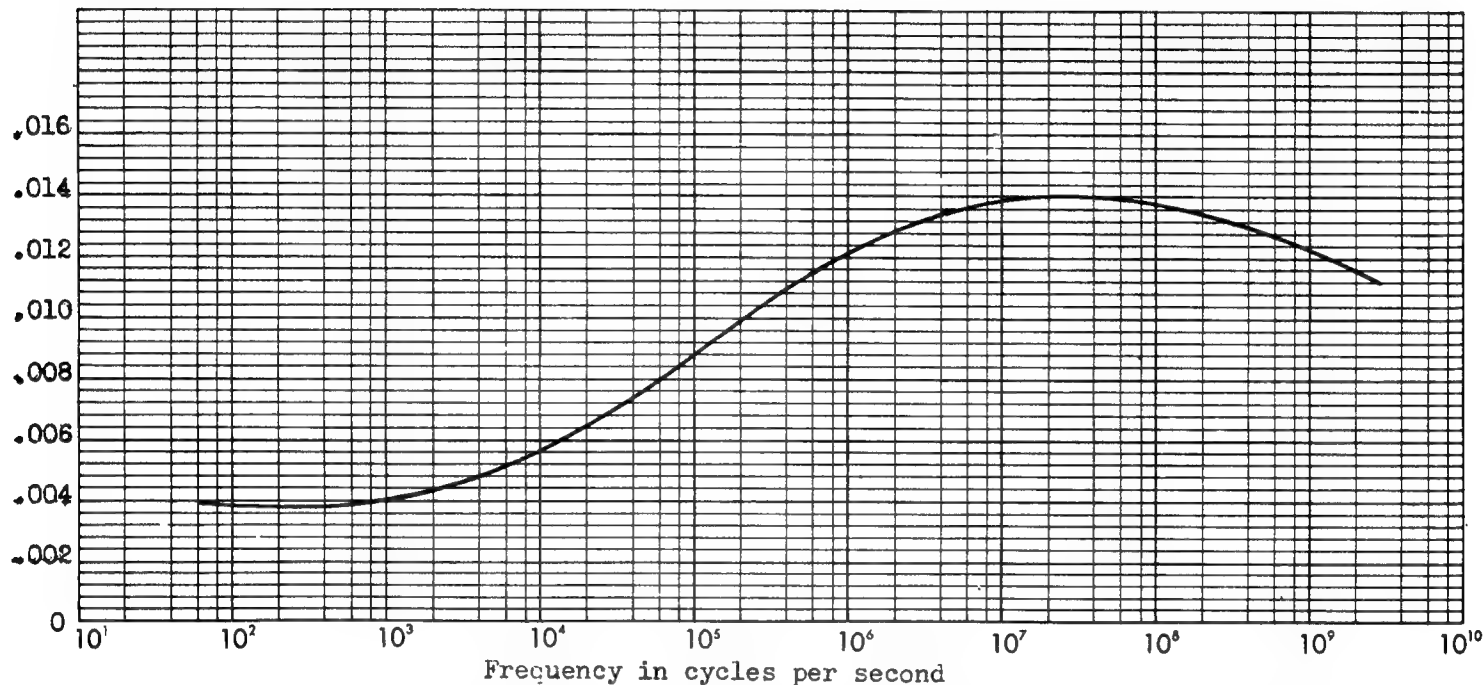
NOTE: The density and  $T_{soft}$  are characteristic of Alvar 11/90. The other properties are those of Alvars in general.



BUTVAR

T=25°C

SHAWINIGAN PRODUCTS CORPORATION

TAN  $\delta$ 

Chemical Name: Polyvinyl butyral. Sample Designation: Butvar, S-622C Low (OH)

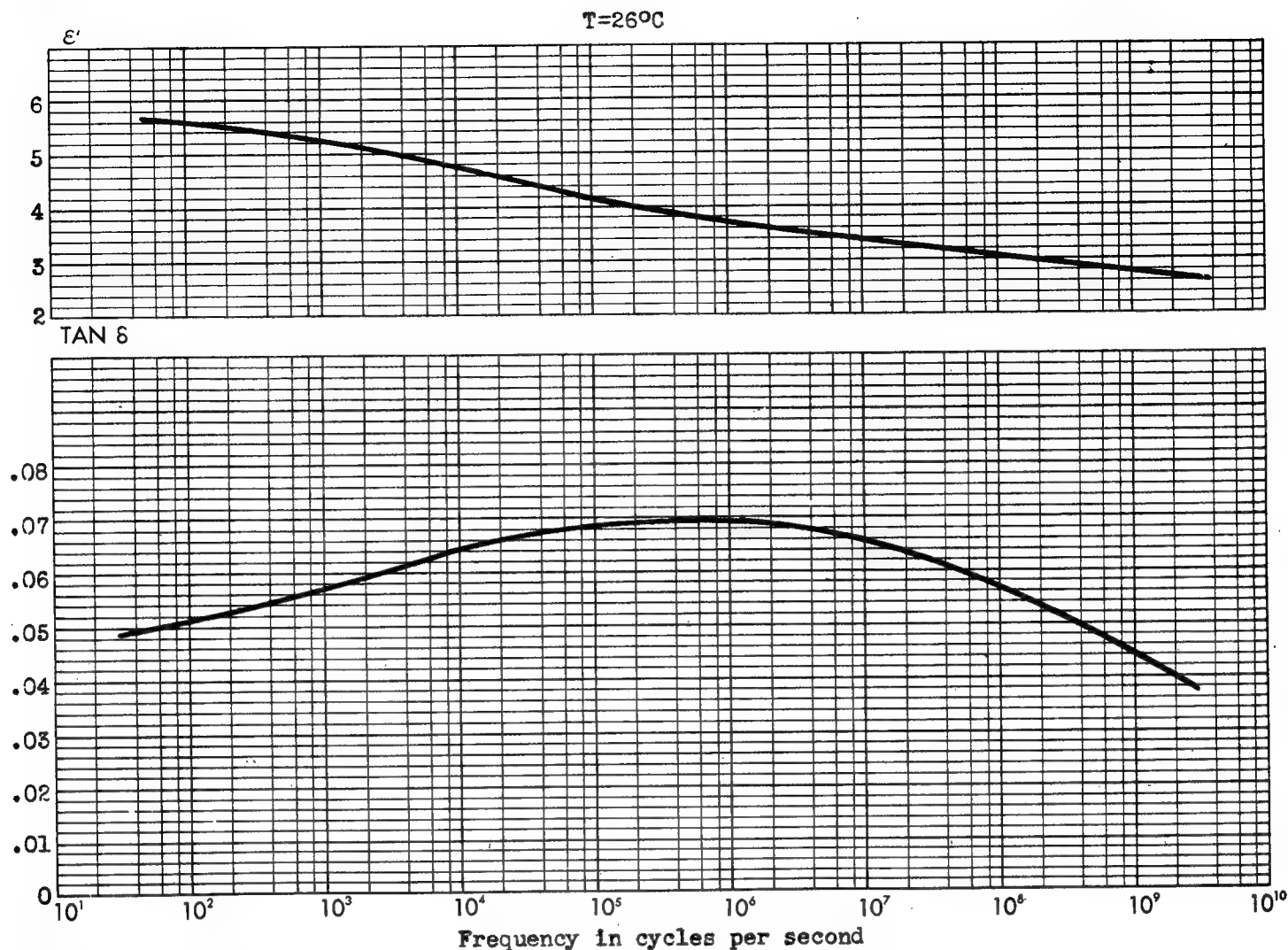
Composition: Linear addition polymer made from polyvinyl acetate and butyraldehyde.

Properties: White powder.  $d^{20}_4=1.1-1.2$ . Ten. Str. 8000-8500. Imp.(Izod) 1.03, 25°C. Flex. Str. 10,000-11,000 at 25°C. Elong. 8%.  $T_{dis}$  60.5°C. Thermoplastic. Chem. Res.: acids, poor; alkalies, good; alcohols, esters, dioxane, ketones, aromatic and chlorinated hydrocarbons, poor; water, good; oxygen, good at room temperature. Sun.: good. Flam.: low.

Methods of Handling: Compr. Mold. 135°C, 1000-2000; Inj. Mold. 204°C, 11,000.

Recommended Uses: Special adhesives, surface coatings, molding compositions, as a component of special thermosetting compositions for coatings, etc.

Availability: Molding powders in commercial quantities under allocation.



Chemical Name: Polyvinyl Butyral Sample Designation: Research Sample D-20

Composition: Linear addition polymer made from polyvinyl acetate and butyraldehyde.

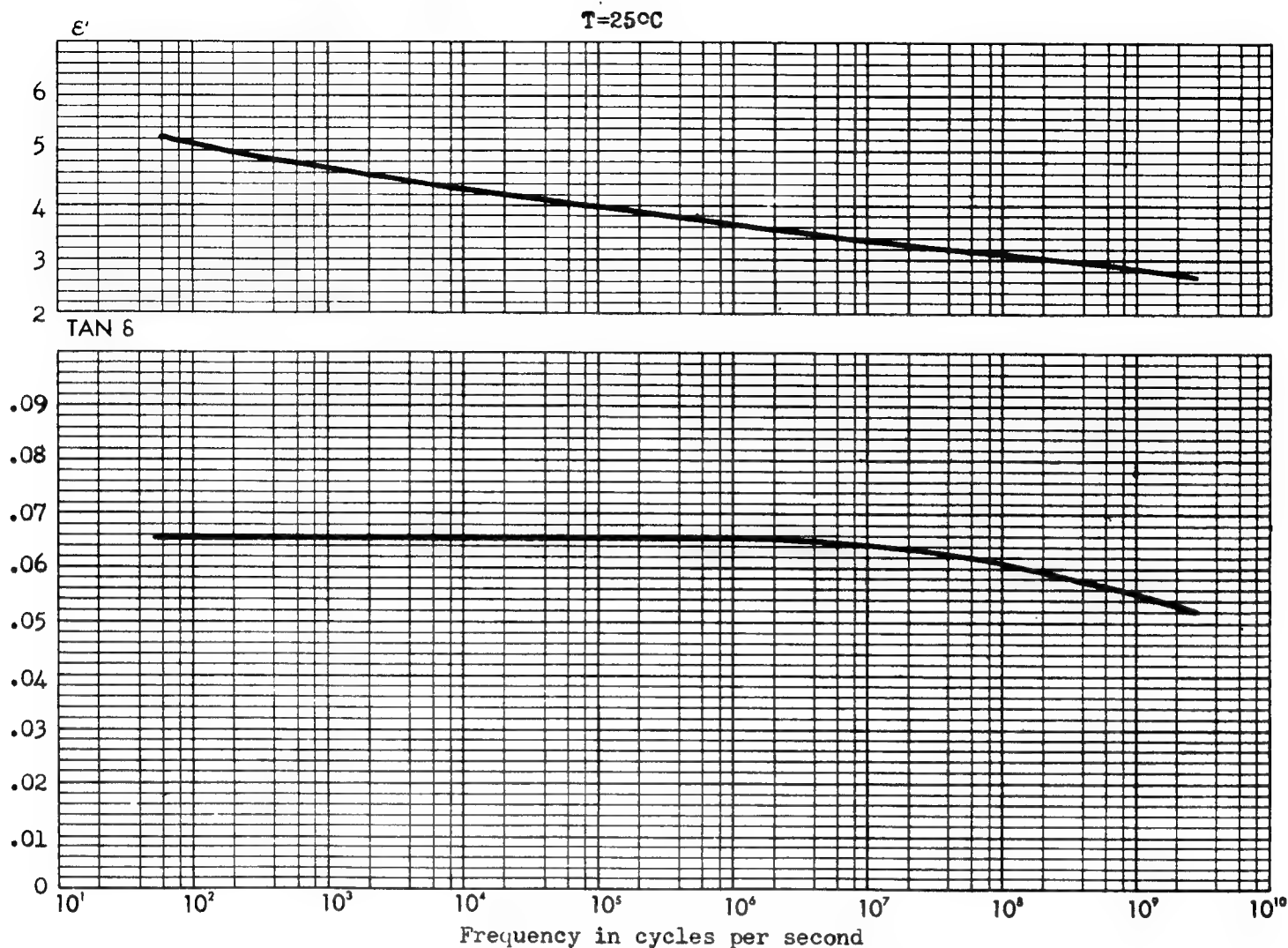
Properties: Opaque, reddish brown (can be modified by pigments).  $d^{25}=1.06$ .  
 Ten. Str. 2500-3000. Shore 46. Elong. 230%. Mach.: poor. Therm. Sta.  $80^{\circ}\text{C}$ .  
 Thermosetting. Chem. Res.: acids, 30%  $\text{H}_2\text{SO}_4$  good; alkalies, 10%  $\text{NaOH}$  good;  
 solvents, poor to good; water, good; oxygen, good. Sun.: slight to medium.  
 Moist. Abs. 1.2-1.5%. Flam. 0.24 in.<sup>2</sup>/sec.

Methods of Handling - Mold: Compr.  $93-121^{\circ}\text{C}$ , 200-500; Extr.  $121-149^{\circ}\text{C}$ .  
 Lacquer: solvent, alcohol; thinner, naphtha.

Recommended Uses: Fabric coating - by calendering or spreading; Raincoat fabric,  
 waterproof sheeting, ponchos. Rubber replacement for many uses.

Availability: Commercial quantities in many modifications of color, cure rate  
 and flexibility.





**Chemical Name:** Polyvinyl butyral **Sample Designation:** Research Sample D-22.

**Composition:** Linear addition polymer made from polyvinyl acetate and butyraldehyde.

**Properties:** Clear, amber colored.  $d^{25}_4=1.06$ . Ten. Str. 1400-1800. Shore 27. Elong. 280%. Mach.: poor. Therm. Sta.  $80^{\circ}\text{C}$ . Thermosetting. Chem. Res.: acids, 30%  $\text{H}_2\text{SO}_4$  good; alkalis, 10% NaOH good; solvents, poor to good; water, good; oxygen, good. Sun.: slight to medium. Moist. Abs. 2.0-2.5%.

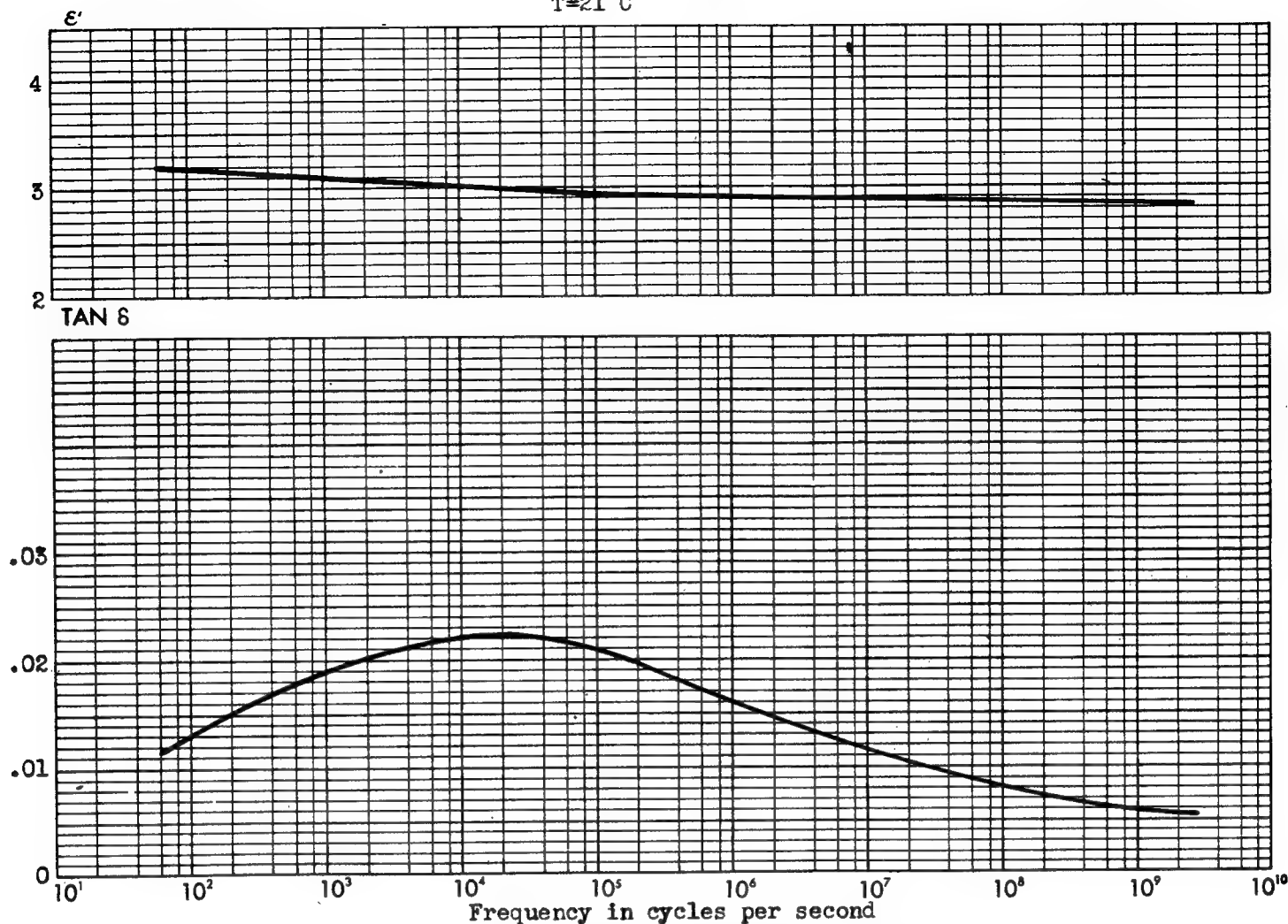
**Methods of Handling - Mold:** Compr.  $95-121^{\circ}\text{C}$ , 200-500; Extr.  $121-149^{\circ}\text{C}$ .

Lacquer: solvent, alcohol; thinner, naphtha.

**Recommended Uses:** Fabric coating - by calendering or spreading; Raincoat fabric, waterproof sheeting, ponchos. Rubber replacements for many uses.

**Availability:** Commercial quantities in many modifications of color, cure rate and flexibility.

T=21°C



Chemical Name: Polyvinyl chloride. Sample Designation: Blend 211

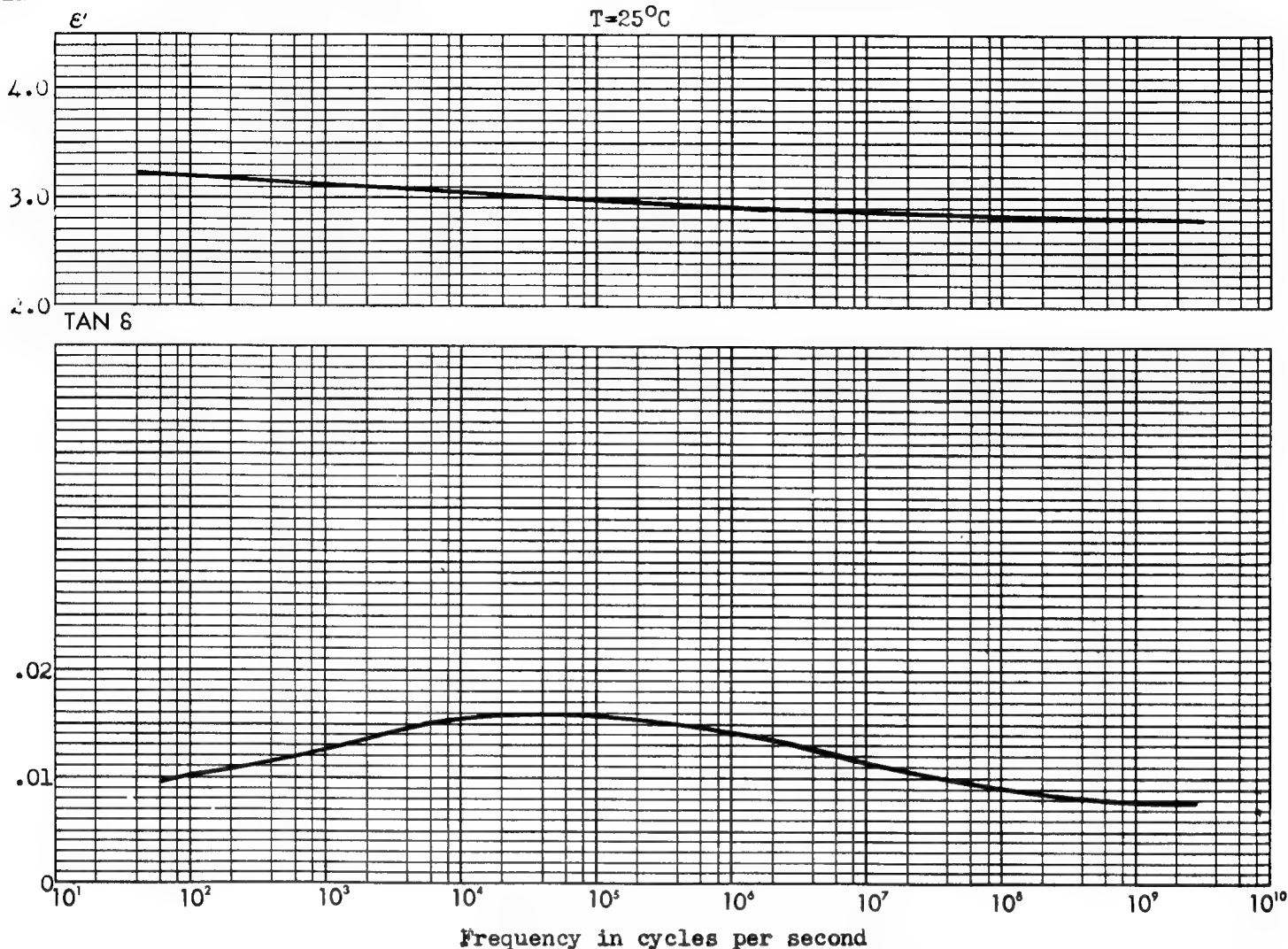
Composition: Linear addition polymer of vinyl chloride (100%).

Properties: Clear, yellowish tinged.  $d_{25}^{25}=1.39-1.45$ . Therm. Sta.: darkens at elevated temperatures. Thermoplastic. Chem. Res.: weak and strong mineral acids, excellent; organic acids, poor; alkalis, excellent; ketones and esters, poor; aromatic hydrocarbons, fair; water, excellent; oxygen, excellent. Sun.: darkens. Moist. Abs. 0.05-0.15%. Flam.: non-flammable.

Methods of Handling: Compression molding, injection molding and extrusion possible.

Recommended Uses: For the manufacture of non-rigid calendering, extrusion and molding compounds.

Availability: Experimental quantity under allocation.



Chemical Name: Vinyl chloride-vinyl acetate copolymer. Sample Designation: Blend 266

Composition: Linear addition copolymer of vinyl chloride (87%) and vinyl acetate (13%).

Properties: Clear, slightly yellow tinged.  $d_{25}^{25}=1.34-1.36$ .  $T_{dis}$  61-64°C. Thermoplastic. Chem. Res.: weak and strong mineral acids, excellent; organic acids, poor; alkalis, excellent; ketones and esters, poor; aromatic hydrocarbons, fair; water, excellent; oxygen, excellent. Sun.: darkens. Moist. Abs. 0.05-0.15%. Flam.: non-flammable.

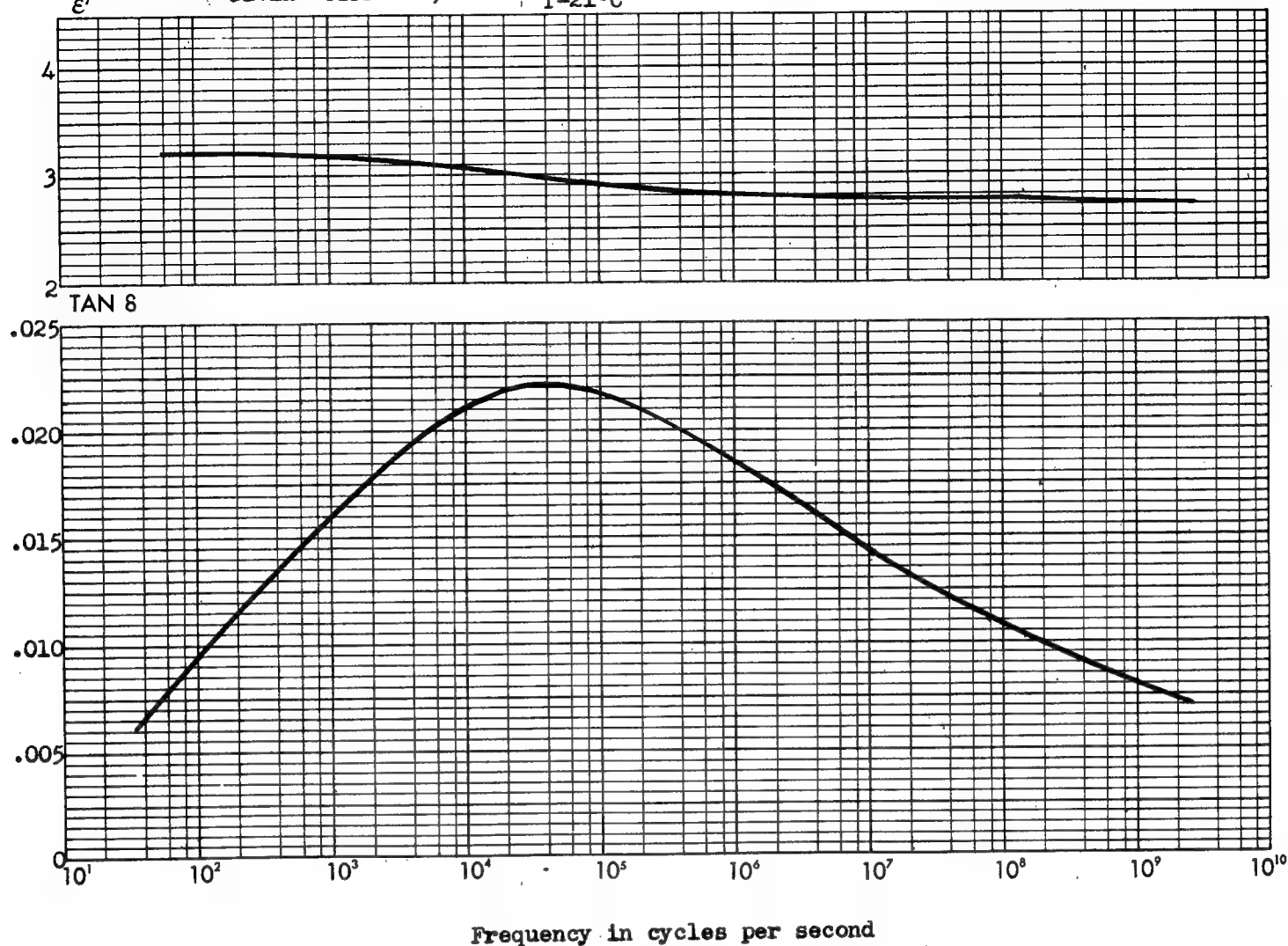
Methods of Handling: Compression molding, injection molding and extrusion possible. Lacquer: done by baking; solvent, ketones; thinner, toluene or high flash naphthas.

Recommended Uses: For the manufacture of baked finishes, molding and extrusion compounds and calendered finishes.

Availability: Powdered white resin in production quantities under allocation.

("DEVEX" TYPE 200)

T=21°C



Chemical Name: Chlorovinyl resin. Sample Designation: Lot B-21

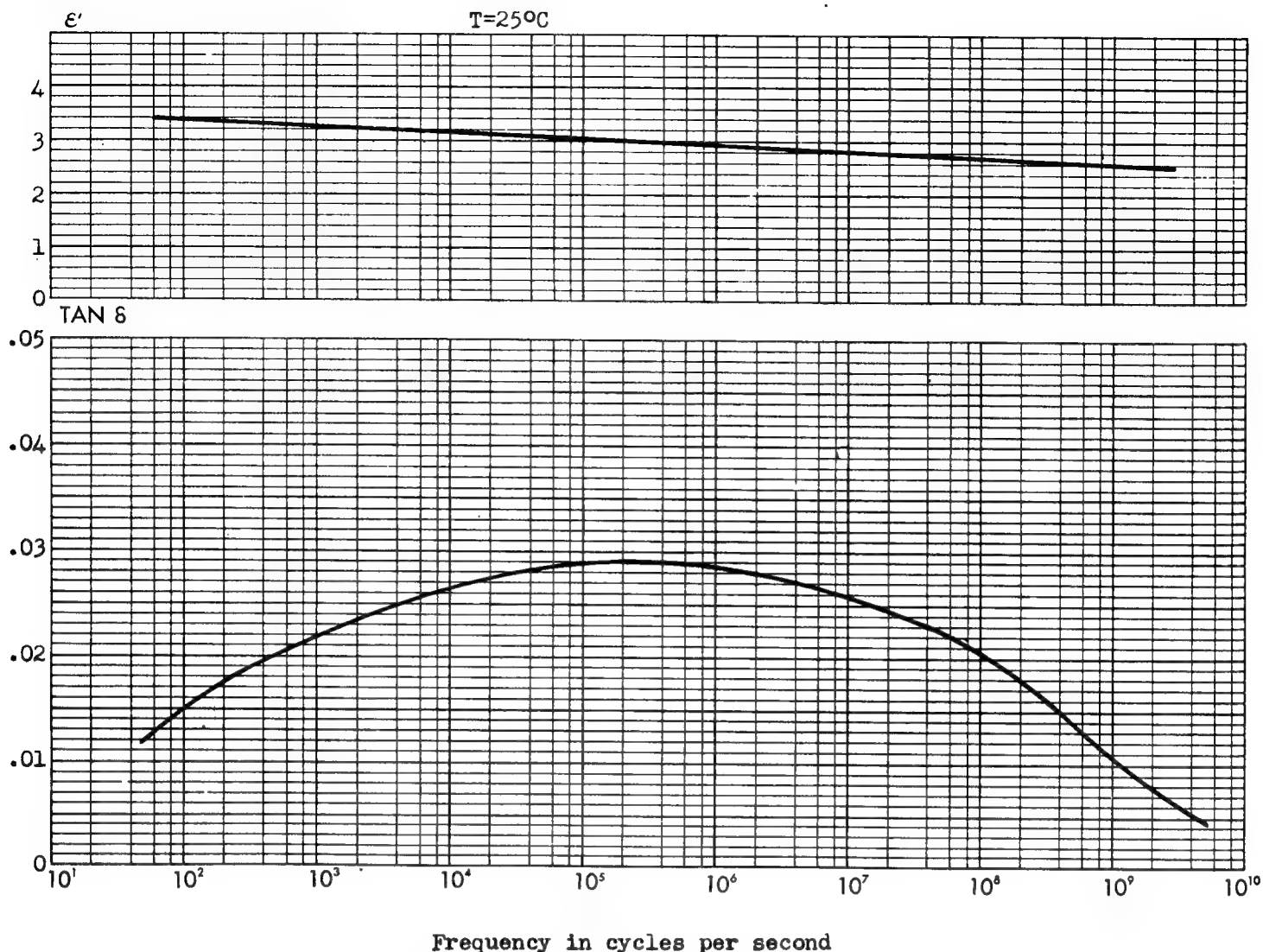
Composition: Linear addition polymer.

Properties: Colorless to yellow.  $d^{25}_4=1.36$ . Ten. Str. 7000-9000. Imp.(Charpy) 0.4-0.65, 25°C. Flex. Str. 9000-14,000, 25°C. Mach.: good.  $T_{\text{soft}}$  80°C. Thermoplastic. Chem. Res.: acids, excellent; alkalies, excellent; solvents, unaffected by alcohols, ethers and hydrocarbons, swollen or dissolved by esters, ketones and chlorinated solvents; water, excellent; oxygen, excellent. Sun.: darkens slightly. Moist. Abs. 0.08%, 100 hrs. at 25°C. Flam.: burns slowly when flame is applied continually but does not support combustion.  $n_D=1.528$ , 20°C.

Methods of Handling: Compr. Mold. 135-149°C, 1000-1500. Extr.: when plasticized 107°C upwards depending upon the amount of plasticizer present.

Recommended Uses: Plasticized compositions for cable coating.

Availability: Molding powder being produced on small pilot plant scale only under allocation.



Chemical Name: Chlorovinyl resin. Sample Designation: 21

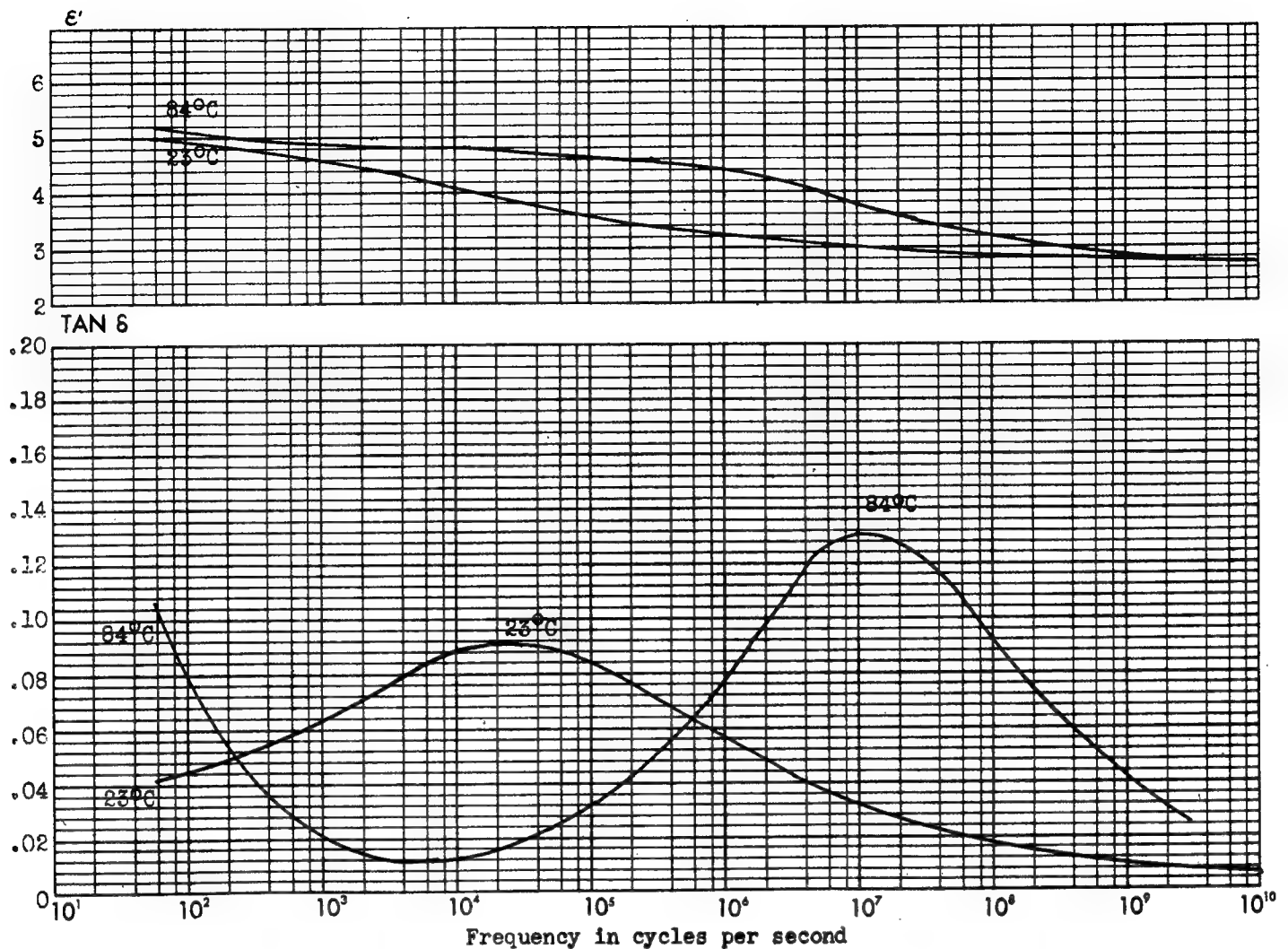
Composition: Linear addition polymer.

Properties: Light yellow.  $d^{25}=1.38$ . Chem. Res.: acids, excellent; alkalies, excellent; solvents, unaffected by alcohols, ethers and hydrocarbons, swollen or dissolved by esters, ketones and chlorinated solvents; water, excellent; oxygen, excellent. Moist. Abs. 0.06%, 100 hrs. at 25°C. Flam.: burns slowly when flame is applied continually but does not support combustion.

Methods of Handling: Extrusion when plasticized.

Recommended Uses: Cable coating.

Availability: Available in experimental quantities only. Molding powder produced on experimental scale only.



Chemical Name: Polyvinylidene chloride

Composition: Linear addition copolymer of vinylidene and vinyl chlorides with plasticizer.

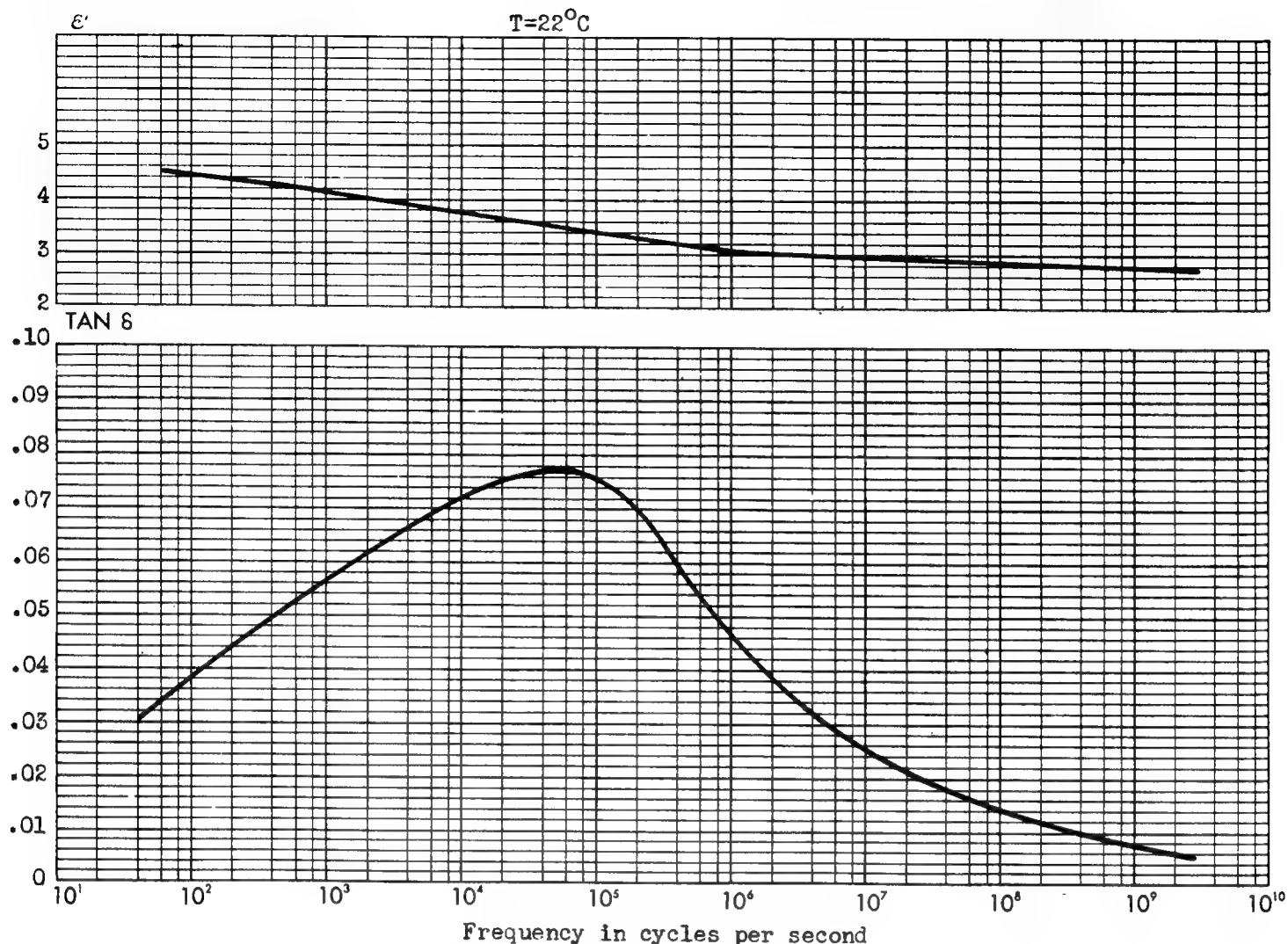
Properties: Properties vary somewhat with degree of crystallization which is influenced by previous history. Clear, yellow translucent.  $d_{25}^{25}=1.68-1.75$ . Ten. Str. 4800-10,000. Rockwell superficial 15y 65-95. Imp.(Izod, unnotched) 1-4. Mod. El.  $0.4-2.4 \times 10^5$ . Comp. Str. 7500-8500. Flex. Str. 25°C 15,000-17,000. Elong. 10-40%. Mach.: good. Spec. Heat 0.32. Therm. Exp.  $15.8 \times 10^{-5}$ . Therm. Cond.  $2.2 \times 10^{-4}$ .  $T_{dis}$  80°C.  $T_{soft}$  150°C. Therm. Sta. 80°C. Thermoplastic. Chem. Res.: acids, excellent; alkalis, excellent; solvents, excellent; water, excellent; oxygen, excellent. Sun.: none. Moist. Abs. 0%. Flam.: none.  $n_D=1.49$ .

Methods of Handling: Compr. Mold. 171°C, 1000.

Recommended Uses: Corrosion resistant, salt water resistant, reasonably good dielectric qualities, exceptional moisture transmission resistance.

Availability: Available in sheets 20" x 20" and 24" x 24" which are 1/64"-1/2" thick in production or experimental quantities under allocation.





Chemical Name: Polyvinylidene chloride

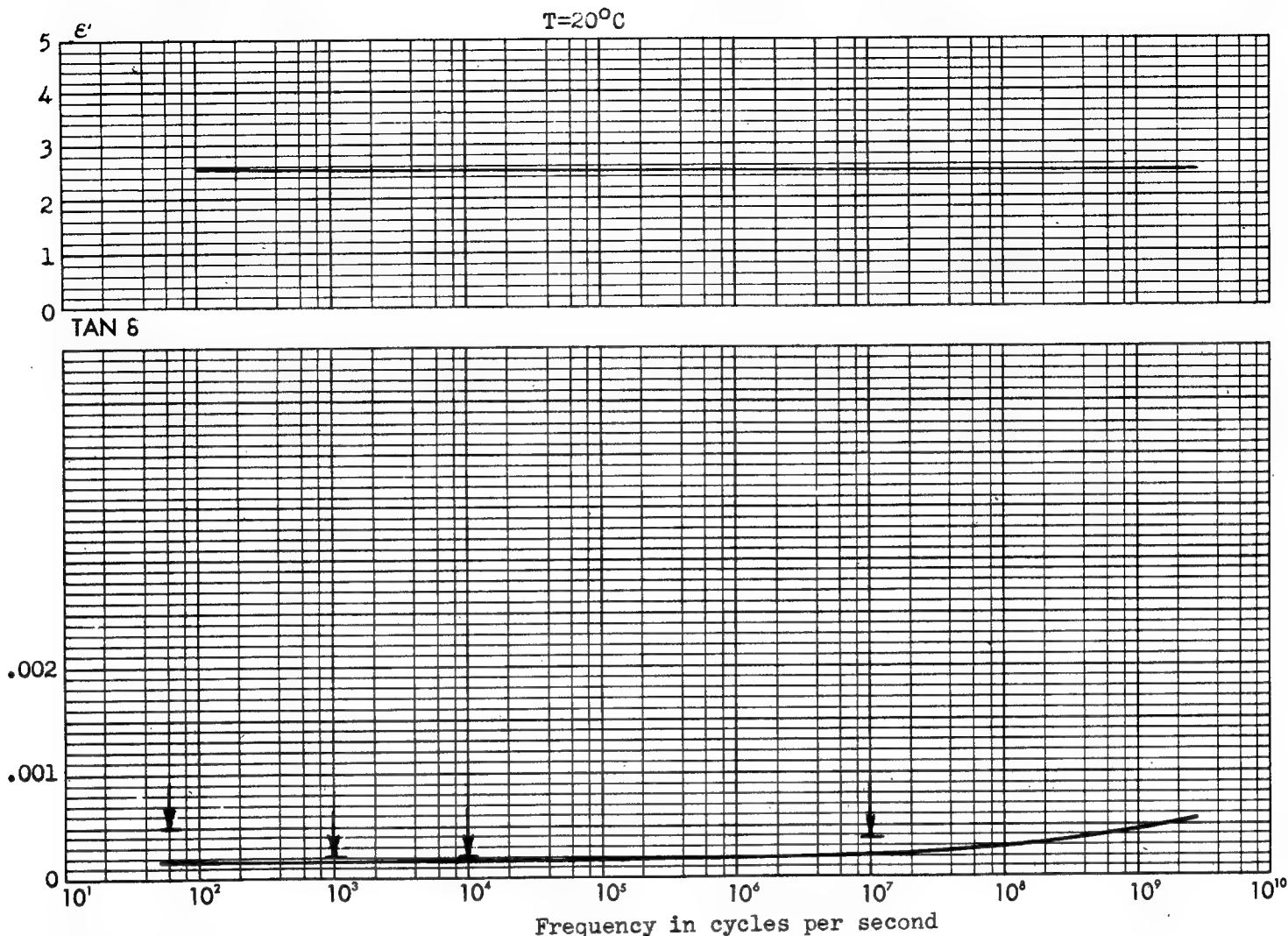
Composition: Linear addition copolymer of vinylidene and vinyl chlorides (92%) with plasticizer (8%).

Properties: Properties vary somewhat with degree of crystallization which is influenced by previous history. Translucent, light amber.  $d_{25}^{25}=1.65-1.72$ . Ten. Str.: unoriented 4000-8000; oriented 15,000-40,000. Rockwell M50-65. Imp.(Izod):  $-40^{\circ}\text{C}$  0.15;  $25^{\circ}\text{C}$  0.6;  $80^{\circ}\text{C}$  4.0 (flexible). Mod. El.  $0.7-2.0 \times 10^5$ . Comp. Str.: at yield point 7500-8500. Flex. Str. 15,000-17,000 at  $25^{\circ}\text{C}$ . Elong. 10-40%. Mach.: good. Spec. Heat 0.32. Therm. Exp.  $1.58 \times 10^{-4}$ . Therm. Cond.  $2.2 \times 10^{-4}$ .  $T_{\text{dis}}$  65-85 $^{\circ}\text{C}$ .  $T_{\text{soft}}$  115-140 $^{\circ}\text{C}$ . Therm. Sta. 70-95 $^{\circ}\text{C}$  (75 $^{\circ}\text{C}$  max. recommended). Thermoplastic. Chem. Res.: acids, excellent except for  $\text{H}_2\text{SO}_4$  and  $\text{HNO}_3$ ; alkalies, good except  $\text{NH}_4\text{OH}$ ; alcohols and aliphatic hydrocarbons, excellent; all other solvents, good to fair; water, excellent; oxygen, excellent. Sun.: slight. Moist. Abs.  $<0.1\%$ . Flam.: self-extinguishing. Elec. Str. 300.  $n_D=1.60-1.63$ .

Methods of Handling: Compr. Mold. 120-200 $^{\circ}\text{C}$ , 500-5000; Inj. Mold. 150-200 $^{\circ}\text{C}$ , 10,000-30,000; Extrusion 160-190 $^{\circ}\text{C}$ .

Recommended Uses: Chemical resistant tubing and fittings; chemical resistant pipe and fittings; electroplating shields and jigs; containers for chemical and medicinal products; containers requiring minimum moisture transmission; monofilaments for screen and cloth; rattan for seat covers.

Availability: Production quantities under allocation.



Chemical Name: Polystyrene

Composition: Linear addition polymer of styrene (100%).

Properties: (Based on injection molded specimens). Transparent, colorless.  
 $d_{25} = 1.05-1.07$ . Ten. Str. 5500-7000. Rockwell M80-M90. Imp.(Izod) 25°C 0.30-0.40  
 Mod. El.: in flexure 25°C  $0.4-0.5 \times 10^6$ . Comp. Str. 25°C 14,000-16,000.  
 Flex. Str. 12,000-16,000. Elong. 2-3% (at breaking load 25°C). Mach.: good.  
 Spec. Heat 0.31-0.33. Therm. Exp.  $6.5-7.6 \times 10^{-5}$ .  $T_{dis}$  77-83°C. Therm. Sta. 60-82°C  
 (dep. on size and shape of piece and stress applied). Thermoplastic. Chem. Res.  
 (<22.2°C): acids, good except conc.  $HNO_3$  and  $HCl$ ; alkalis, excellent; ketones and  
 aromatic hydrocarbons, poor; alcohols, good; water, excellent; oxygen, fair.  
 Sun.: may discolor slightly. Moist. Abs. 0.00%. Flam.: burns if flame is applied  
 continuously; decomposes at 250°C. Elec. Str.: short time 500-700 (1/8" thick);  
 step-by-step 500-600 (1/8" thick).  $n_D = 1.59$ .

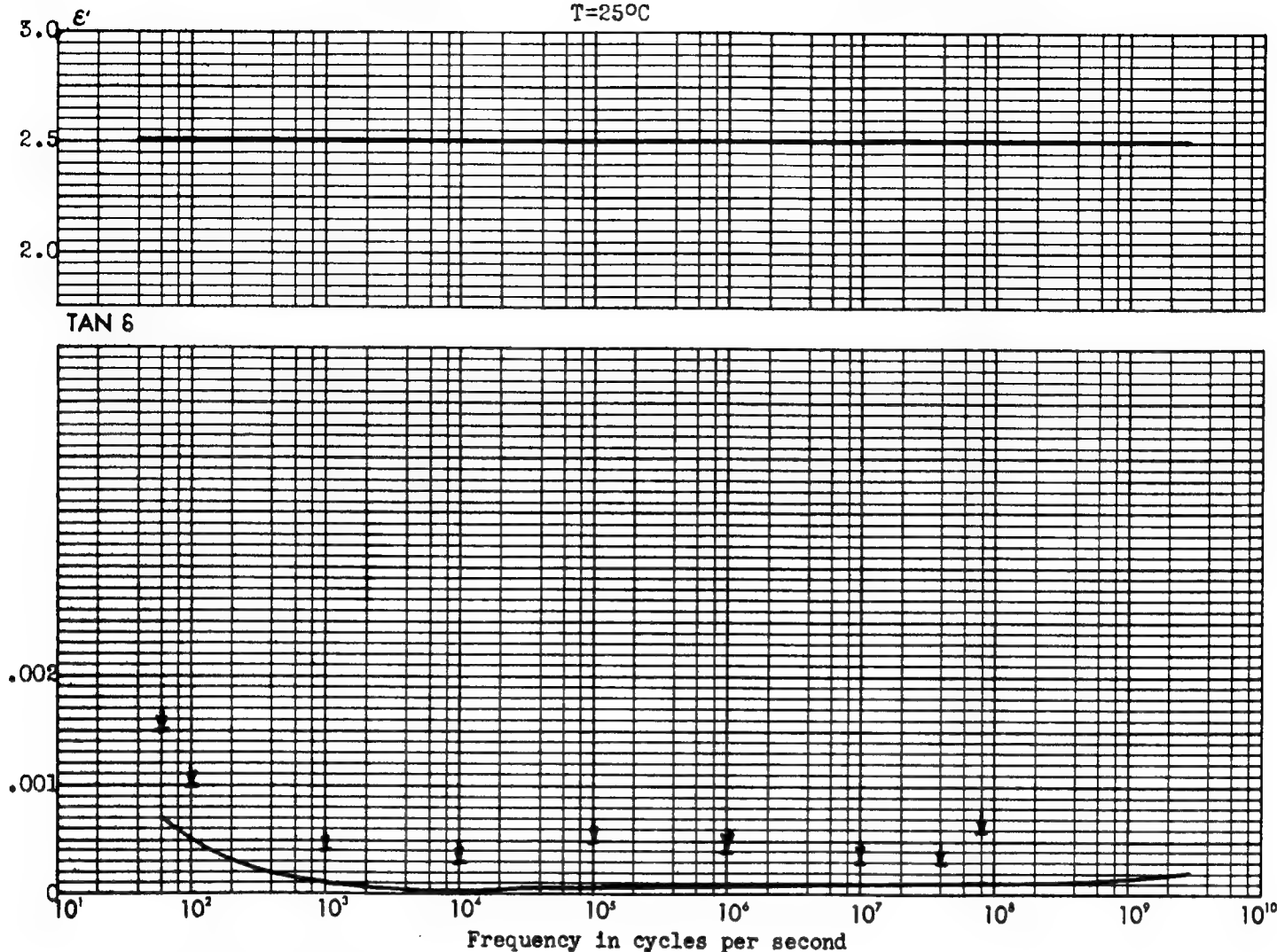
Methods of Handling: Compr. Mold. 121-177°C, 2000-10,000; Inj. Mold. 177-232°C,  
 10,000-30,000 (refers to transfer molding); Extr. 177-232°C.

Recommended Uses: Recommended especially where exceptionally low power factor,  
 high dielectric strength and insulation resistance, and exceptionally low water  
 absorption are required. The molded parts have excellent acid and alkali  
 resistance, and retain their dimensions after molding for a long period of time.

Availability: Granular molding powder in production quantities.



T=25°C



Chemical Name: Polystyrene

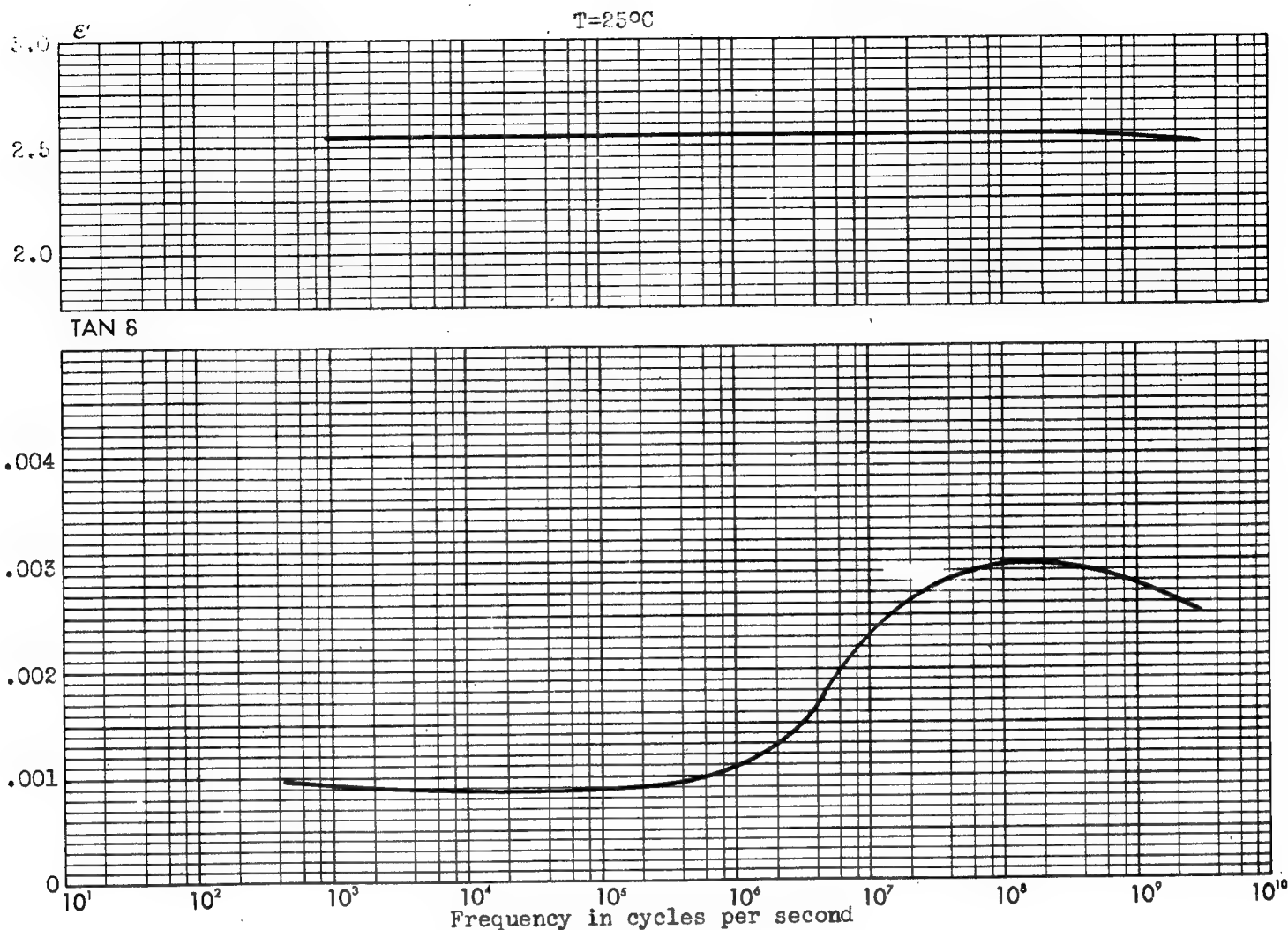
Composition: Linear addition polymer of styrene (99.7%) with miscellaneous volatile substances (.3%).

Properties:  $d_{25}^{25}=1.054$ . Ten. Str. 3000-8500. Rockwell M55-M95. Imp.(Izod) 25°C, 0.26-0.40. Mod. El.: in compression  $3.0-5.6 \times 10^5$ . Comp. Str. 12,000-17,000. Shear. Str. 6000-8000. Flex. Str. 25°C 4800-19,000. Elong.: none. Mach.: good with cooling liquids. Spec. Heat 0.31-0.33. Therm. Exp.  $6-8 \times 10^{-6}$ . Therm. Cond.  $1.8-2 \times 10^{-4}$ .  $T_{dis}$  74-88°C. Thermoplastic. Chem. Res.: acids, good; alkalies, good; solvents, good except for aromatic hydrocarbons, esters and chlorinated solvents; water, excellent. Sun.: yellows. Flam.: will not support combustion. Arc Res.: excellent.  $n_D=1.59$ . Elec. Str. 500-700.

Methods of Handling: Inj. Mold. 149-177°C pressure depending on mold. Compression molding and extrusion possible.

Recommended Uses: Electrical and optical products as well as any product that can be made by injection molding.

Availability: Plant production.



Chemical Name: Polystyrene

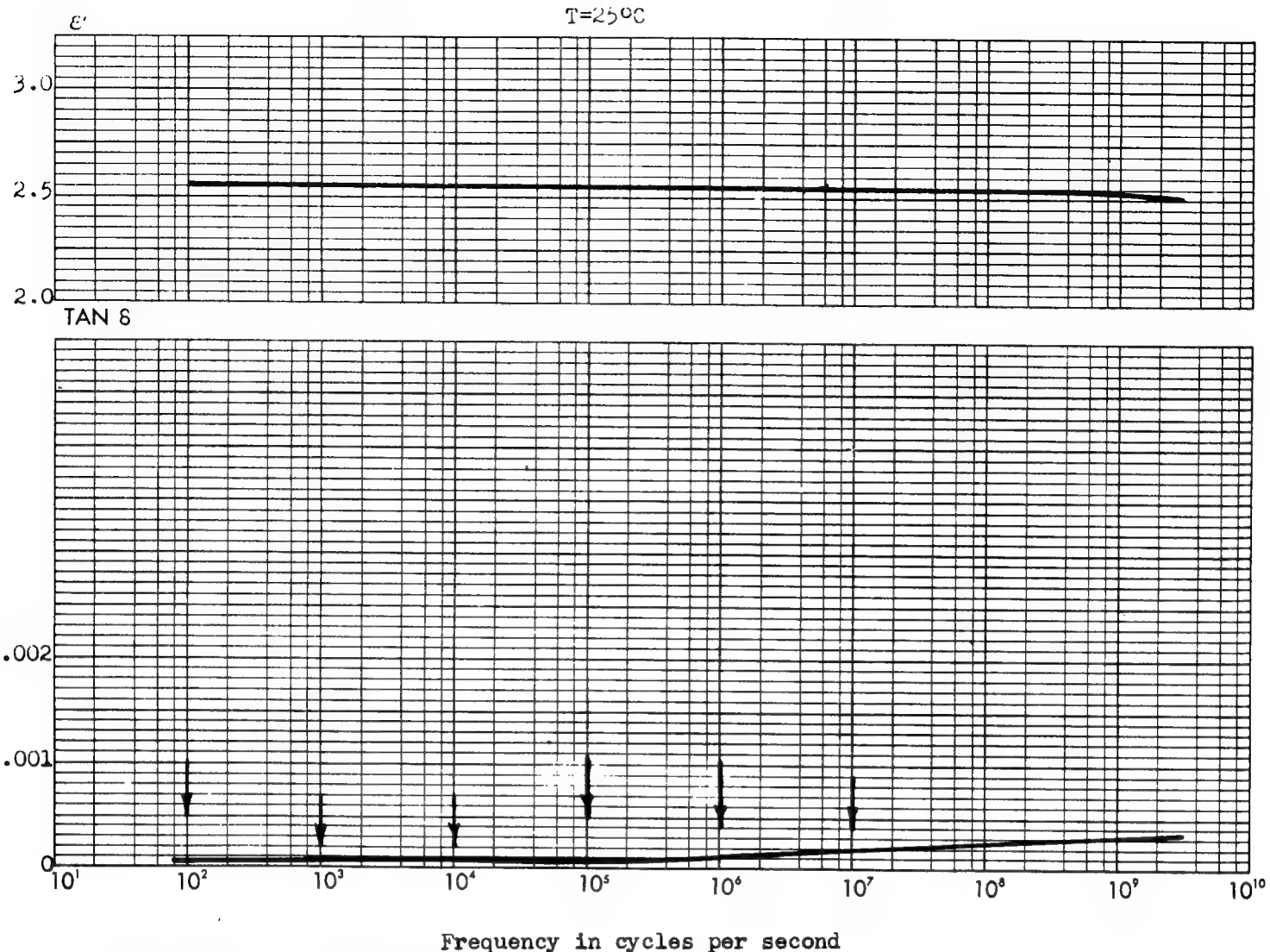
Composition: Linear addition polymer of styrene (97.2%) with plasticizer (2.5%) and miscellaneous volatile substances (.3%).

Properties: Clear, colorless.  $d_{28.5}^{25} = 1.0563$ . Ten. Str. 5000-7000. Rockwell F52. Imp. (Izod) 25°C 0.3-0.4. Mod. El.: in compression  $3.75-4.25 \times 10^5$ . Shear. Str. 6000-7000. Flex. Str. 25°C 14,000-19,000. Mach.: good if lubricated with coolant fluid.  $T_{dis}$  76-80°C. Chem. Res.: acids, good; alkalies, good; solvents, good except for aromatic hydrocarbons, esters and chlorinated solvents; water, good. Sun.: yellows slightly in direct sunlight. Moist. Abs. 0.0-0.4%. Flam.: 1.0 inches/minute. Elec. Str. 500-700. Arc Res.: excellent.  $n_D = 1.59$ .

Methods of Handling: Casting and machining only.

Recommended Use: Fabrication of transparent objects.

Availability: Plant production.



Chemical Name: Polystyrene

Composition: Linear addition polymer of styrene (99%).

Properties: Water white.  $d_{25}^{25}=1.054$ . Ten. Str. 8500. Imp.(Izod) 0.05. Flex. Str. 17,500 at  $25^{\circ}\text{C}$ . Elong. 3%. Mach.: good. Spec. Heat 0.32.  $T_{dis}$   $82^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: non-oxidizing acids, excellent; alkalies, excellent; water, excellent; oxygen, excellent. Sun.: slight discoloration.  $n_D=1.593$ .

Methods of Handling: Compression molding and injection molding possible.

Recommended Uses: Coil forms, Styron Foam and Polyfibre.

Availability: Commercial production under allocation.

<u>Frequency</u>	<u>Temp.</u>	<u><math>\epsilon'</math></u>	<u><math>\tan \delta</math></u>
3000 megacycles	27°C	1.05	<.00003
3000 megacycles (90% Humidity)	22°C	1.05	<.00003

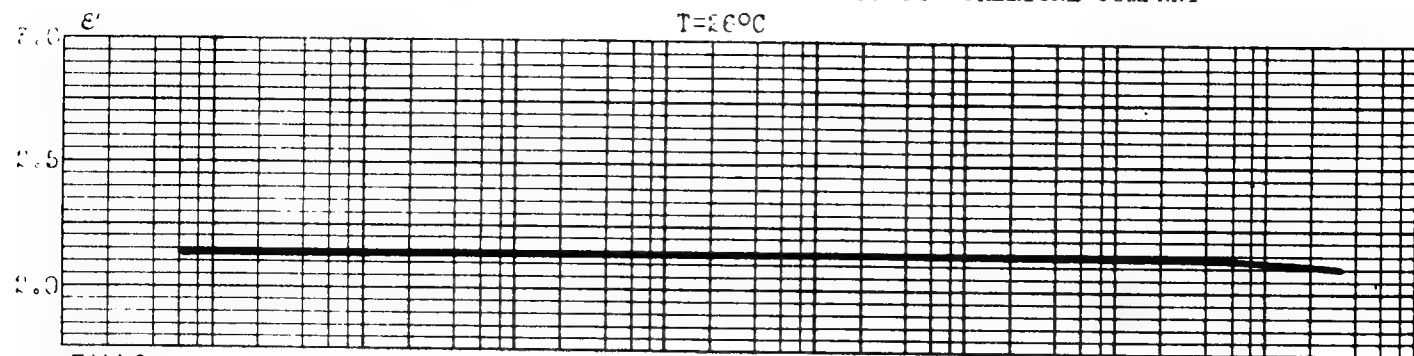
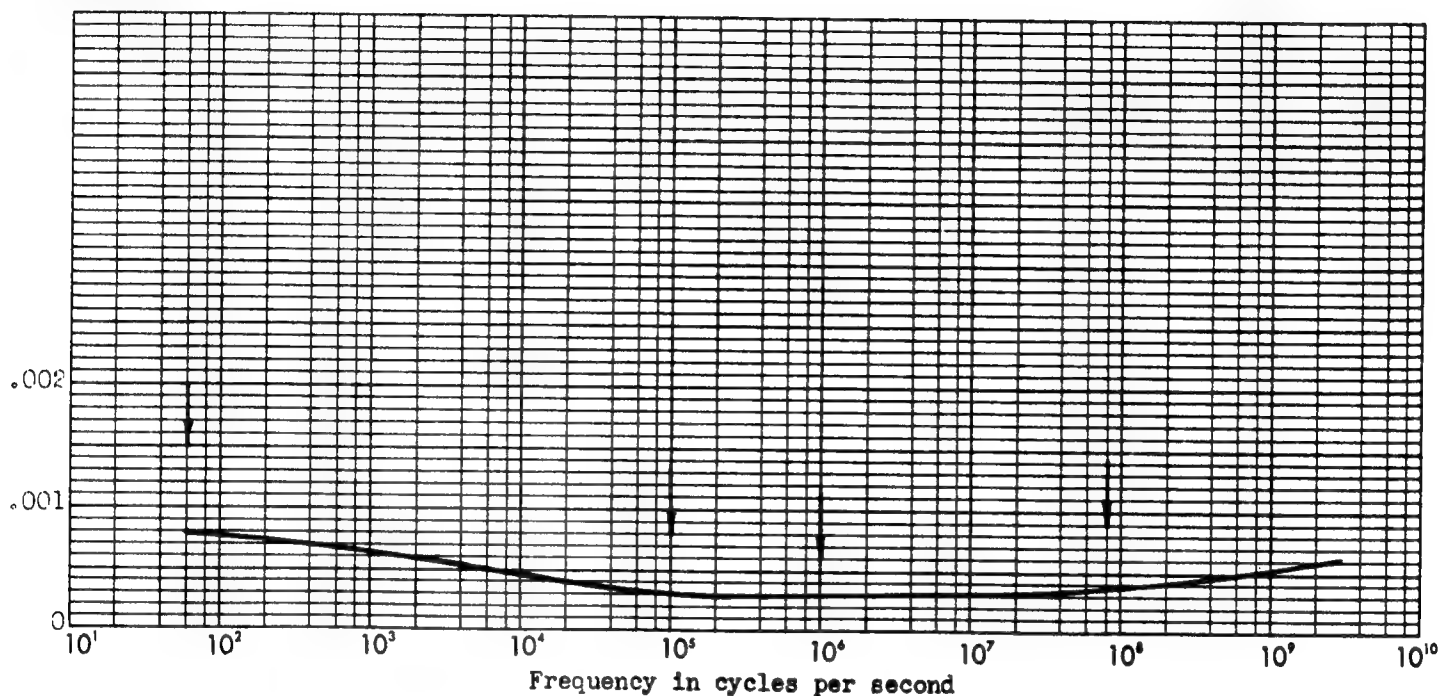
Composition: Linear addition polymer of styrene (100%).

Properties: White, with minute non-connected cells.  $d^{25}=0.16$  (can be made in a wide range of densities). Ten. Str. 13-38. Imp.(Izod) 0.063. Mod. El.: in bending 1250. Comp. Str. 1150-3000. Mach.: fair. Therm. Cond.  $1.14 \times 10^{-4}$ .  $T_{dis}$  70°C.  $T_{soft}$  85°C. Thermoplastic. Therm. Sta.: poor. Chem. Res.: acids, good; alkalies, good; aromatic and chlorinated solvents, poor; water, good. Sun.: yellows slightly. Moist. Abs.: very low. Flam.: rapid.

Methods of Handling: Sawing, cutting, etc.

Recommended Uses: Flotation, thermal insulation and electrical insulation i.e. in radomes.

Availability: Various blocks and sheets in semi-plant scale under allocation.

TAN  $\delta$ 

Composition: Linear addition polymer of styrene (100%)

Sample Designation: d851 #520

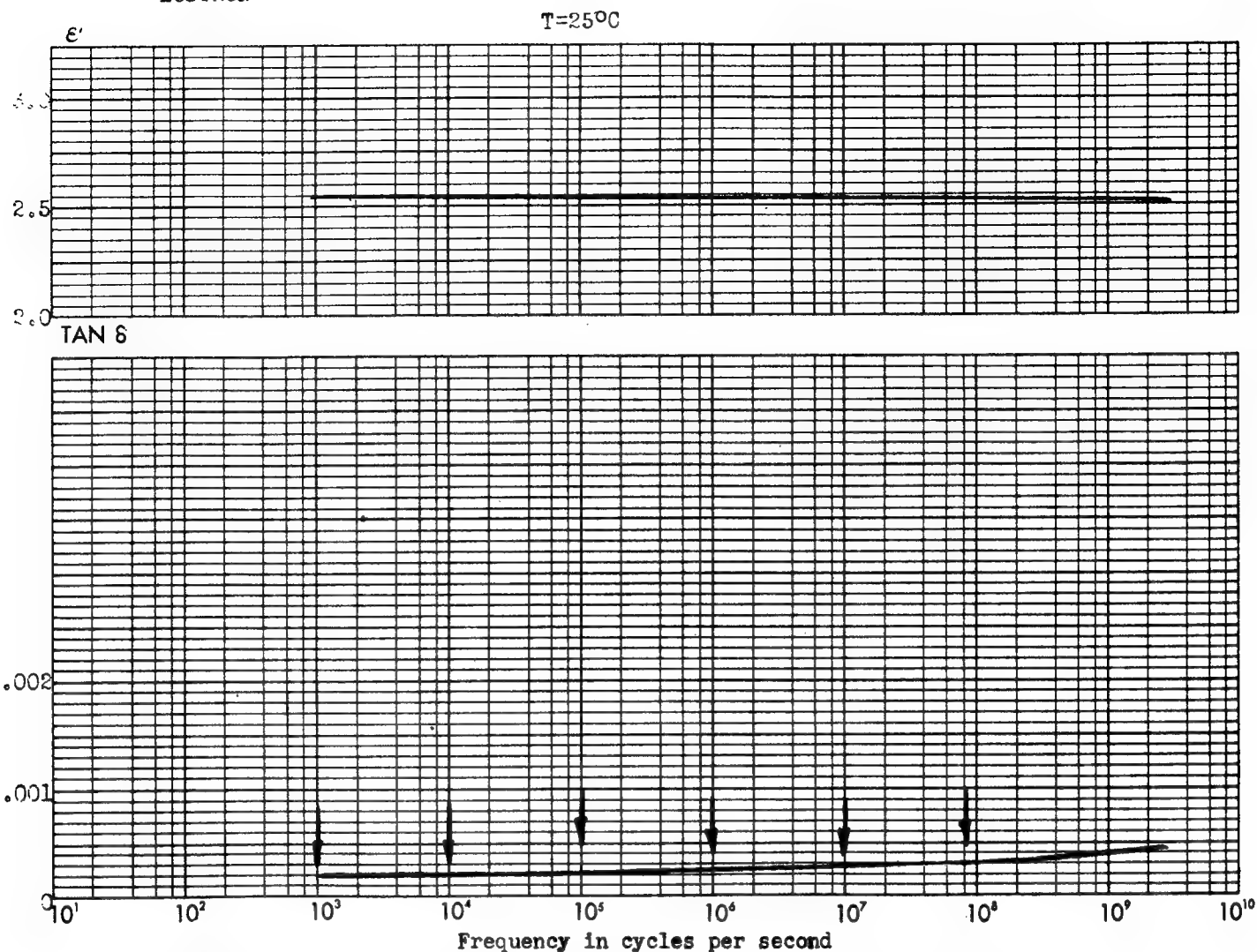
Properties: White, opaque.  $d^{20} = .65-1.05$  (for moldings). Ten. Str. 3000-6000. Imp. (Izod) 1.00-1.25.  $T_{dis}$  70-80°C. Thermoplastic. Chem. Res.: non-oxidizing acids, good; alkalis, good; aromatic and chlorinated solvents, poor; water, good; oxygen, good.

Methods of Handling: Bag molding technique: 15 psi pressure and temperatures of 80-100°C.

Recommended Uses: Radomes.

Availability: Bats of fiber approx. 10" wide in production quantities under strict allocation.

\*The designation Q-107 applies to fibers 1 micron average diameter; and also to moldings made from these fibers for radomes.



Chemical Name: Polystyrene Sample Designation: Research Sample No. D-276

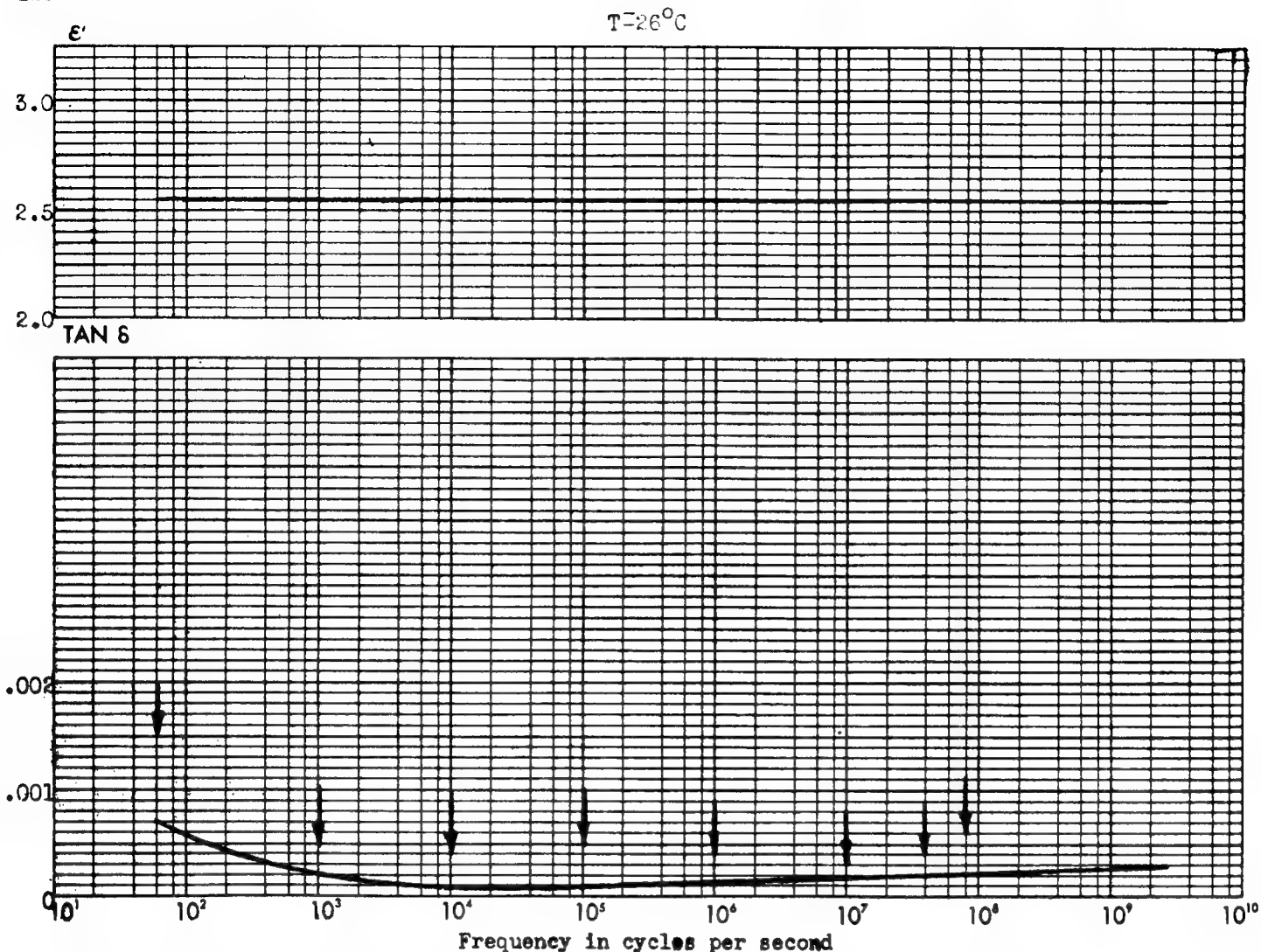
Composition: Linear addition polymer of polystyrene (98%) with unpolymerized materials (2%).

Properties: Colorless transparent.  $d_{25}^{25}=1.05$ . Ten. Str. 5500-7000. Rockwell M80-M90. Imp.(Izod): 0.30-0.40 at -40°C, 25°C & 80°C. Mod. El.: Ten.  $1.7-3 \times 10^5$ ; Comp. 3.5 to  $5.0 \times 10^5$ ; Flex.  $4.0-4.7 \times 10^5$ . Comp. Str. 12,000-17,000. Shear. Str. 6000-8000. Flex. Str.: -40°C 18,000-24,000; 25°C 8000-19,000; 80°C 8000-13,000. Elong. 2.0-3.0%. Mach.: good. Spec. Heat 0.32. Therm. Exp.  $6-8 \times 10^{-5}$ . Therm. Cond.  $1.9 \times 10^{-4}$ . Tdis 76°C. Tsoft 75-85°C. Therm. Sta. 60-70°C. Thermoplastic. Chem. Res.: acids, excellent; alkalis, excellent; aromatic and chlorinated hydrocarbons, esters, some ethers and some terpenes, poor; aliphatic hydrocarbons, mineral and vegetable oils, glycols and lower alcohols, good; water, excellent; oxygen, good. Sun.: yellows slightly. Moist. Abs. 0.04-0.06%. Flam. 0.75-1.5 in./min., slow-burning. Elec. Str.: short time 500-700; step-by-step 450-600. Surf. Res.  $> 10^{21}$ . Arc Res.: excellent.  $n_D=1.59$ .

Methods of Handling: Cast. 100-150°C, 1-5 days; Compr. Mold. 135-191°C, 1000-10,000; Inj. Mold. 163-260°C, 10,000-30,000; Extr. 191-288°C; Lacquer: baking to remove solvents only 38-149°C dep. on solvents; solvents are benzene, toluene, xylene and styrene monomer.

Recommended Uses: Electrical and radio parts, bottle closures, battery boxes, funnels and containers for corrosive chemicals, etc.

Availability: Commercial quantities.



Chemical Name: Polystyrene Sample Designation: Research Sample No. D-334

Composition: Linear addition polymer of polystyrene (98%) and unpolymerized materials (2%).

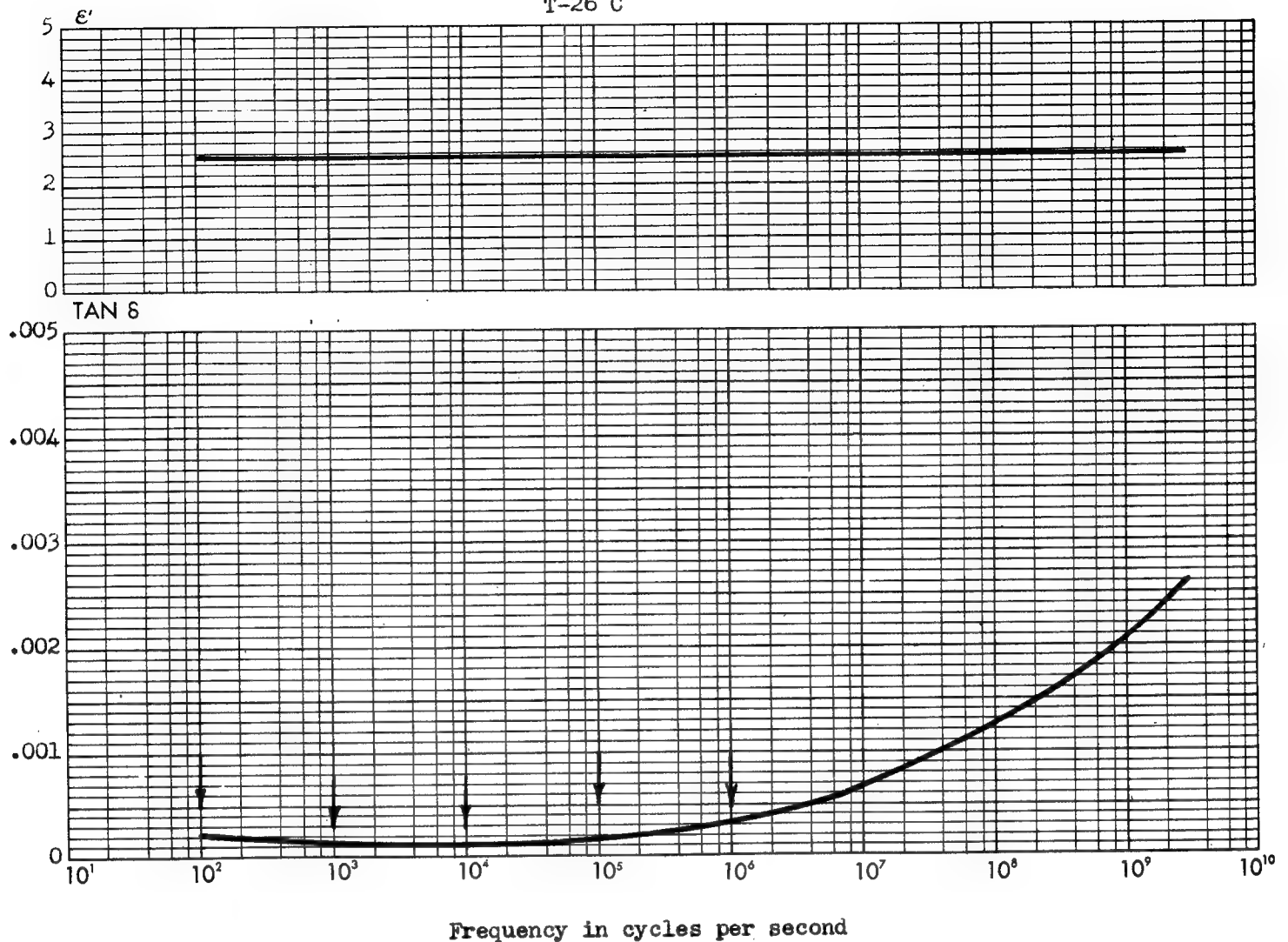
Properties: Crystal clear.  $d_{25}^{25}=1.05-1.06$ . Ten. Str. 5500-7500. Rockwell M80-M90. Imp.(Izod):  $-40^{\circ}\text{C}$  0.30-0.40;  $25^{\circ}\text{C}$  0.30-0.40;  $80^{\circ}\text{C}$  0.30-0.40. Mod. El.: Ten.  $1.7 \times 10^5$  to  $3.0 \times 10^5$ ; Comp.  $3.5 \times 10^5$  to  $5.0 \times 10^5$ ; Flex.  $4.0 \times 10^5$  to  $4.7 \times 10^5$ . Comp. Str. 12,000-17,000. Shear. Str. 6000-8000. Flex. Str.:  $-40^{\circ}\text{C}$  18,000-24,000;  $25^{\circ}\text{C}$  8000-19,000;  $80^{\circ}\text{C}$  8000-13,000. Elong. 2.0-3.0%. Mach.: good. Spec. Heat 0.32. Therm. Exp.  $6-8 \times 10^{-5}$ . Therm. Cond.  $1.9 \times 10^{-4}$ .  $T_{dis}$   $76^{\circ}\text{C}$ .  $T_{soft}$   $75-85^{\circ}\text{C}$ . Therm. Sta.  $60-70^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids, excellent; alkalies, excellent; aromatic and chlorinated hydrocarbons, esters, some ethers and some terpenes, poor; aliphatic hydrocarbons, mineral and vegetable oils, glycols and lower alcohols, good; water, excellent; oxygen, good. Sun.: yellows slightly. Moist. Abs. 0.04-0.06%. Flam.: 0.75-1.5 in./min., slow-burning. Elec. Str.: short time 500-700; step-by-step 450-600. Surf. Res.  $>10^{21}$ . Arc Res.: excellent.  $n_D=1.59$ .

Methods of Handling: D-334 was cast at  $100-160^{\circ}\text{C}$ , 5 days. Compr. Mold.: cast mat'l. could be ground and compr. molded  $149-177^{\circ}\text{C}$ , 2000-4000. Inj. Mold.: could be ground and inj. molded  $204-232^{\circ}\text{C}$ , 10,000-30,000.

Recommended Uses: For rigid, high-frequency insulation, or for compounding into flexible cable coating.

Availability: Sample D-334 was made in laboratory equipment. New equipment would have to be provided for manufacture of this material.



$T=26^{\circ}\text{C}$ 

Composition: Linear addition polymer of polystyrene (100%).

Properties: Clear, slightly hazy.  $d_{25.5}^{25} = 1.0493$ . Rockwell H58. Mach.: excellent. Therm. Exp.  $8 \times 10^{-5}$ .  $T_{\text{soft}} 82^{\circ}\text{C}$ . Therm. Sta.  $75^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids, excellent except oxidizing acids; alkalies, excellent; chlorinated and aromatic hydrocarbons, poor; water, excellent. Sun.: slight discoloration. Moist. Abs. 0.1% after 1 hr. in boiling water. Flam.: slow.  $n_D = 1.591$ .

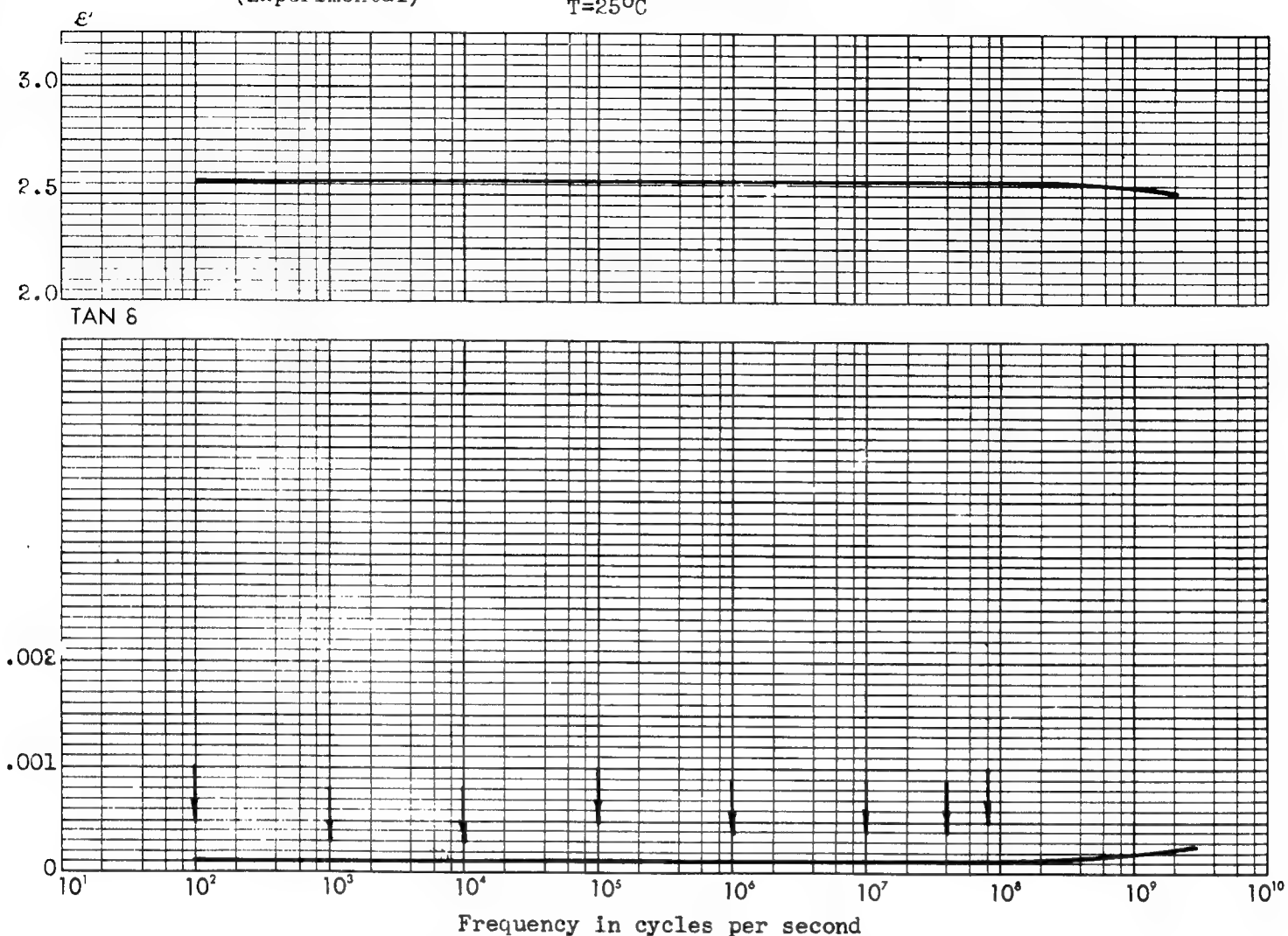
Methods of Handling: Cast.  $80^{\circ}\text{C}$  max., time and temp. cycle depends on mass and shape.

Recommended Uses: Optical elements requiring homogeneity and dimensional stability.

Availability: In production for military purposes.



T=25°C

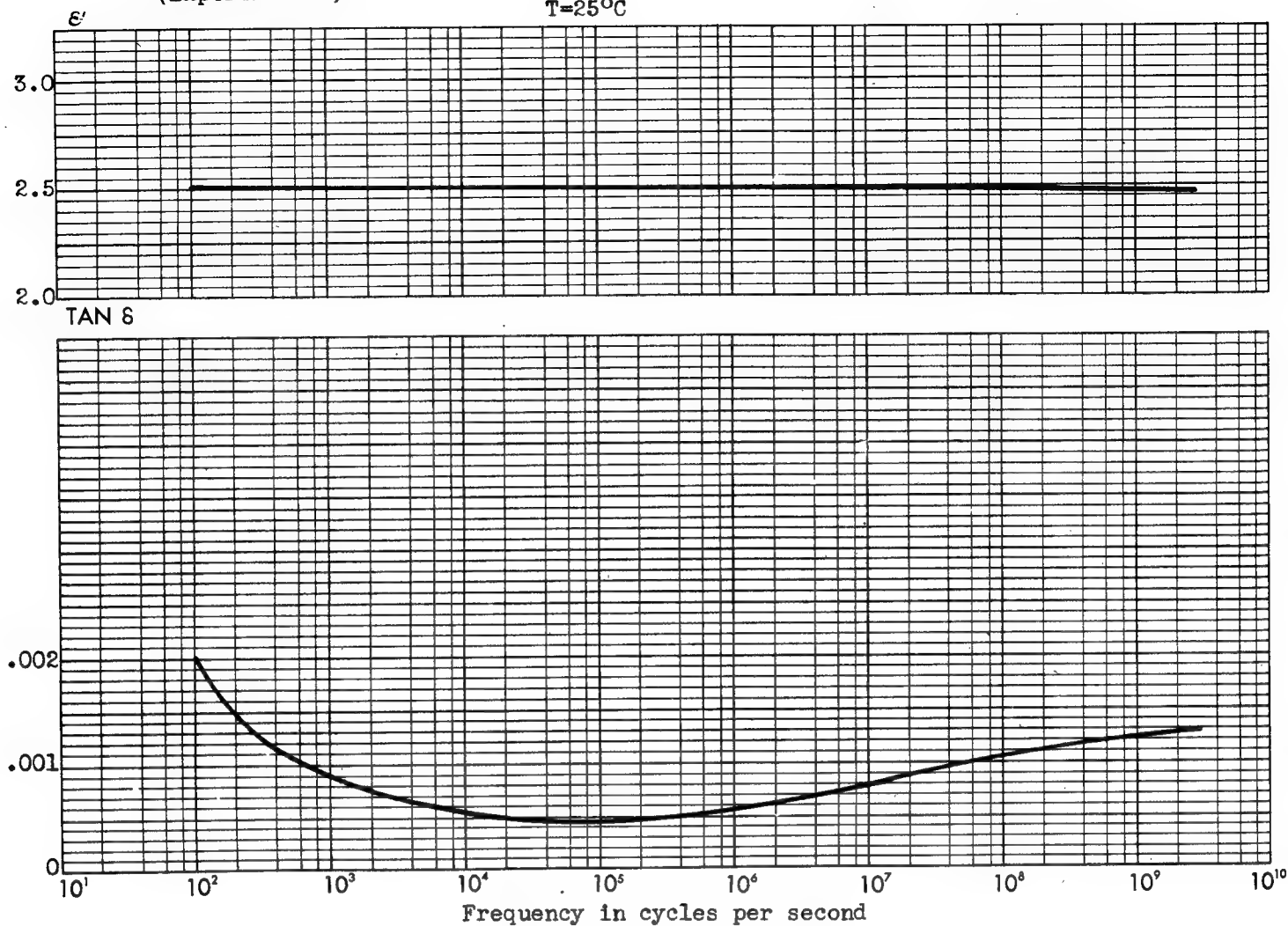


Composition: Linear addition polymer of styrene. Styrene, The Dow Chemical Company's N-100, further purified by fractional distillation in vacuo and polymerized in vacuo.

Properties: Approximately those of most commercial polystyrenes.

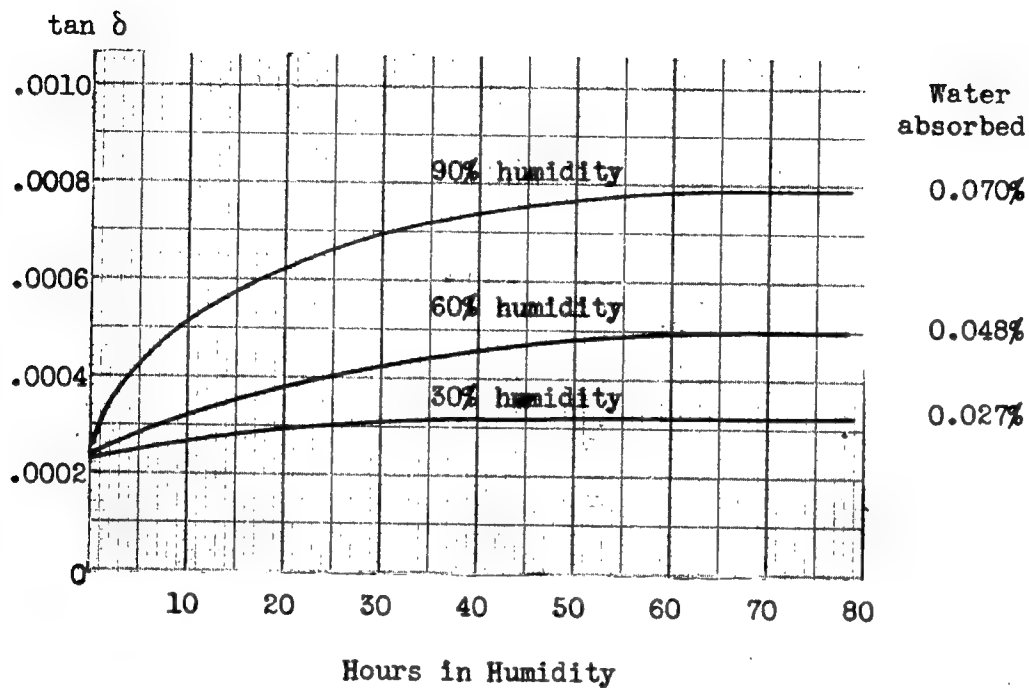
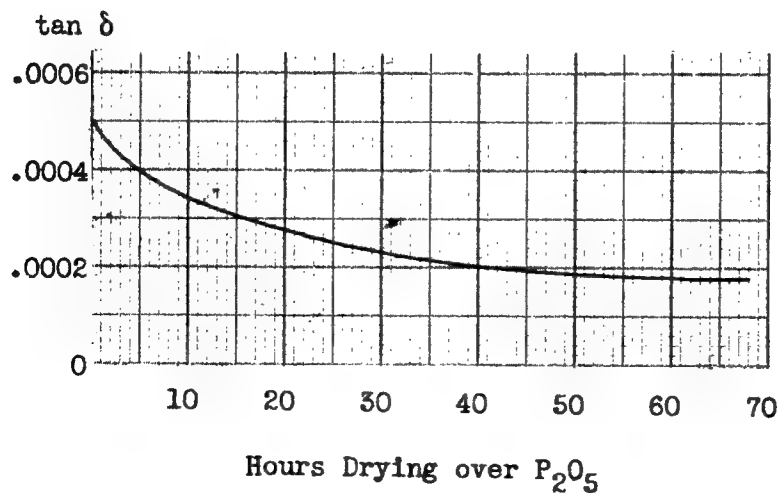
NOTE: See graph on polystyrene cast in air for comparison.

T=25°C



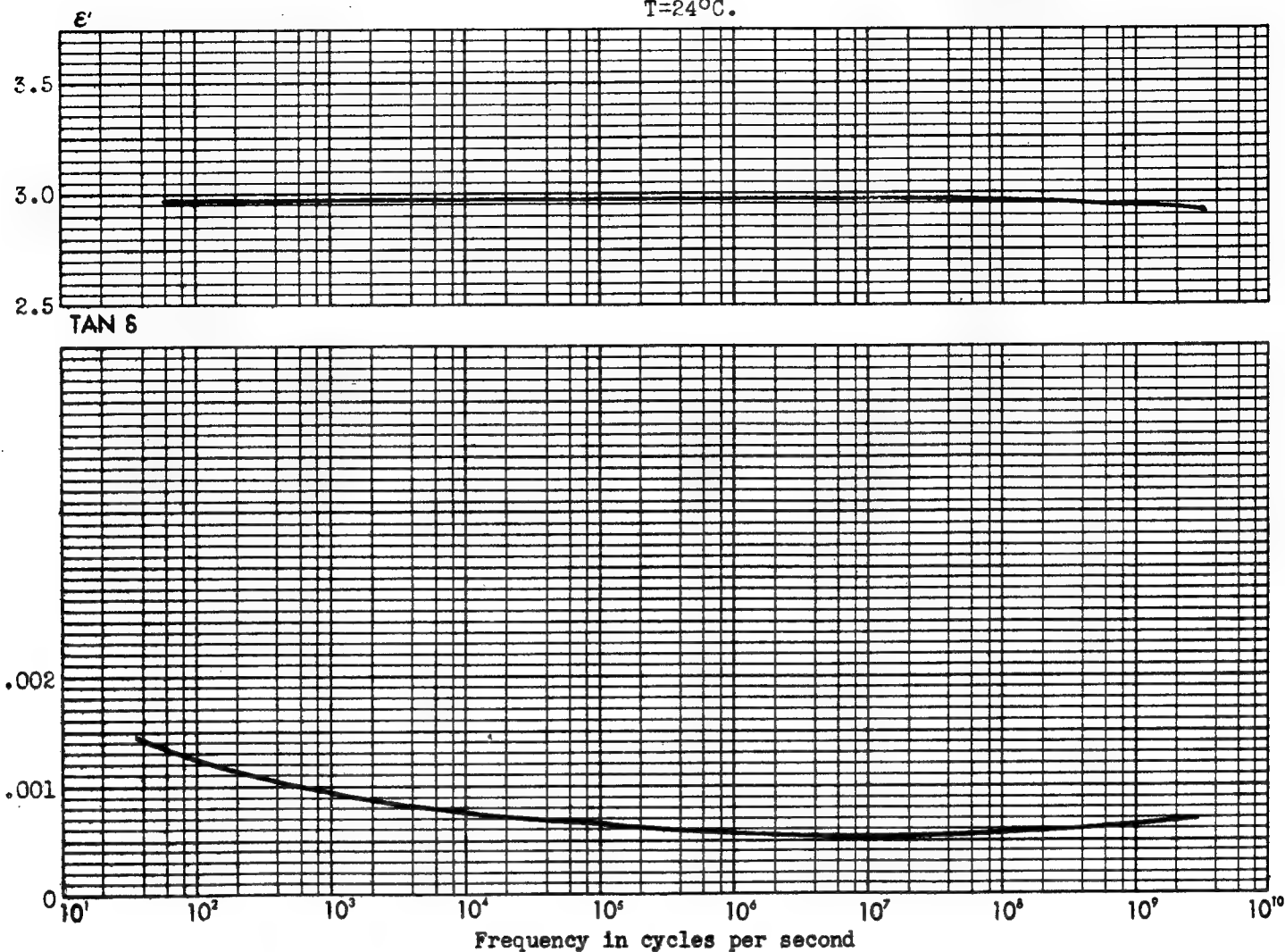
Composition: Linear addition polymer of styrene. Styrene, The Dow Chemical Company's N-100, further purified by fractional distillation in vacuo, but polymerized in the presence of air.

Properties: Approximately those of most commercial polystyrenes except for a higher electrical loss.

3,000 megacycles;  $T=25^{\circ}\text{C}$ Change in Loss vs. Time in Humidity Chamber  
(Pre-dried samples)Change in Loss vs. Time in Drying Chamber  
(From 60% humidity)

Samples: 5/8" diameter, 2" long, with longitudinal 0.17" diameter hole. Dow's C-176 polystyrene compression molded.

T=24°C.

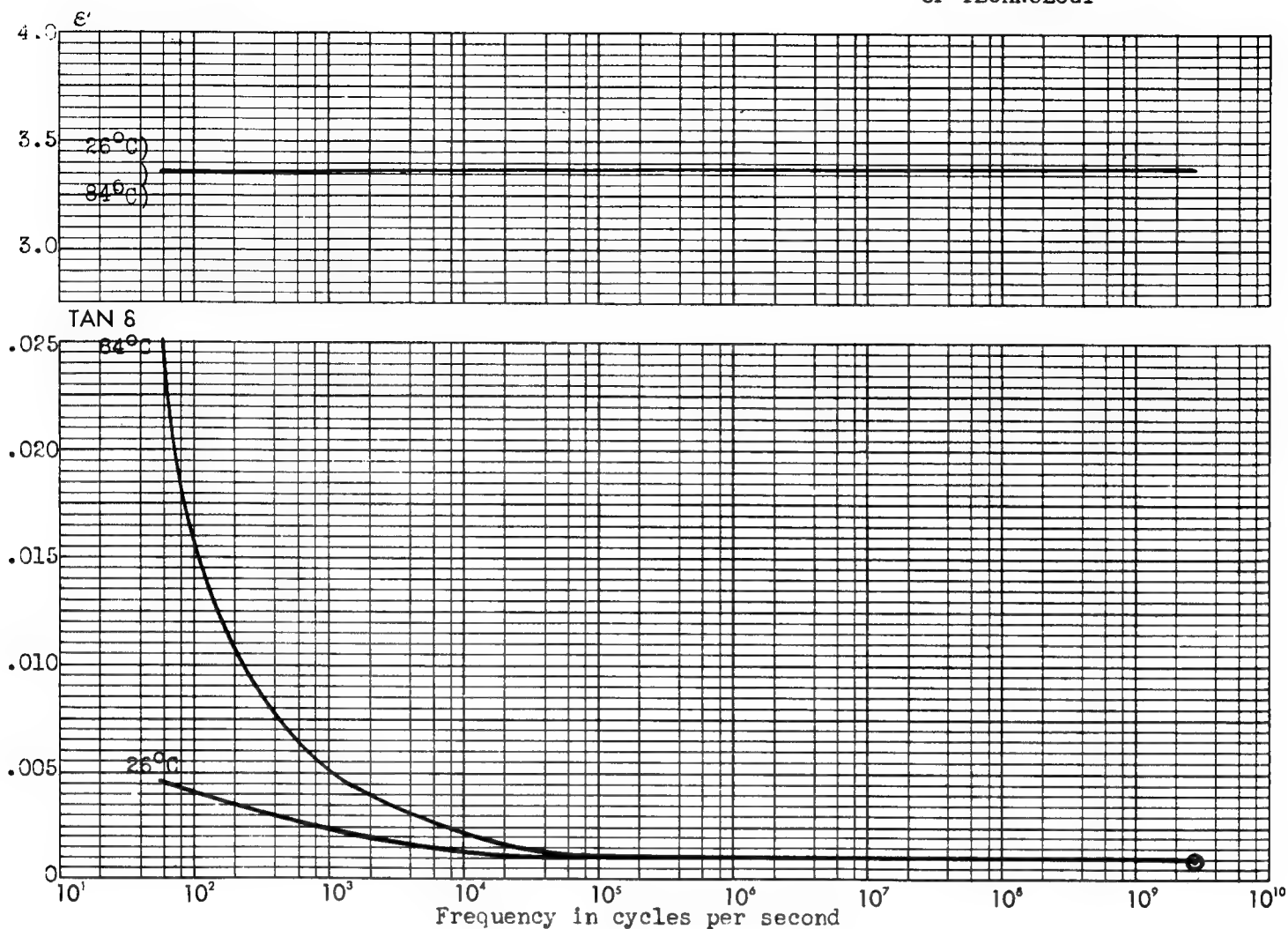


Chemical Name: Polystyrene and glass.

Composition: Polystyrene, Dow Chemical Company's C-176 (52%); glass, Corning glass #714 leached with acid and dried at 500°C (48%).

Properties: Opaque, white.  $d^{25}=1.37$ . Therm. Exp. -18°C to 25°C,  $4.3 \times 10^{-5}$ ; 25°C to 60°C,  $4.8 \times 10^{-5}$ .

Method of Handling: Compr. Mold. 155°C, 3200.



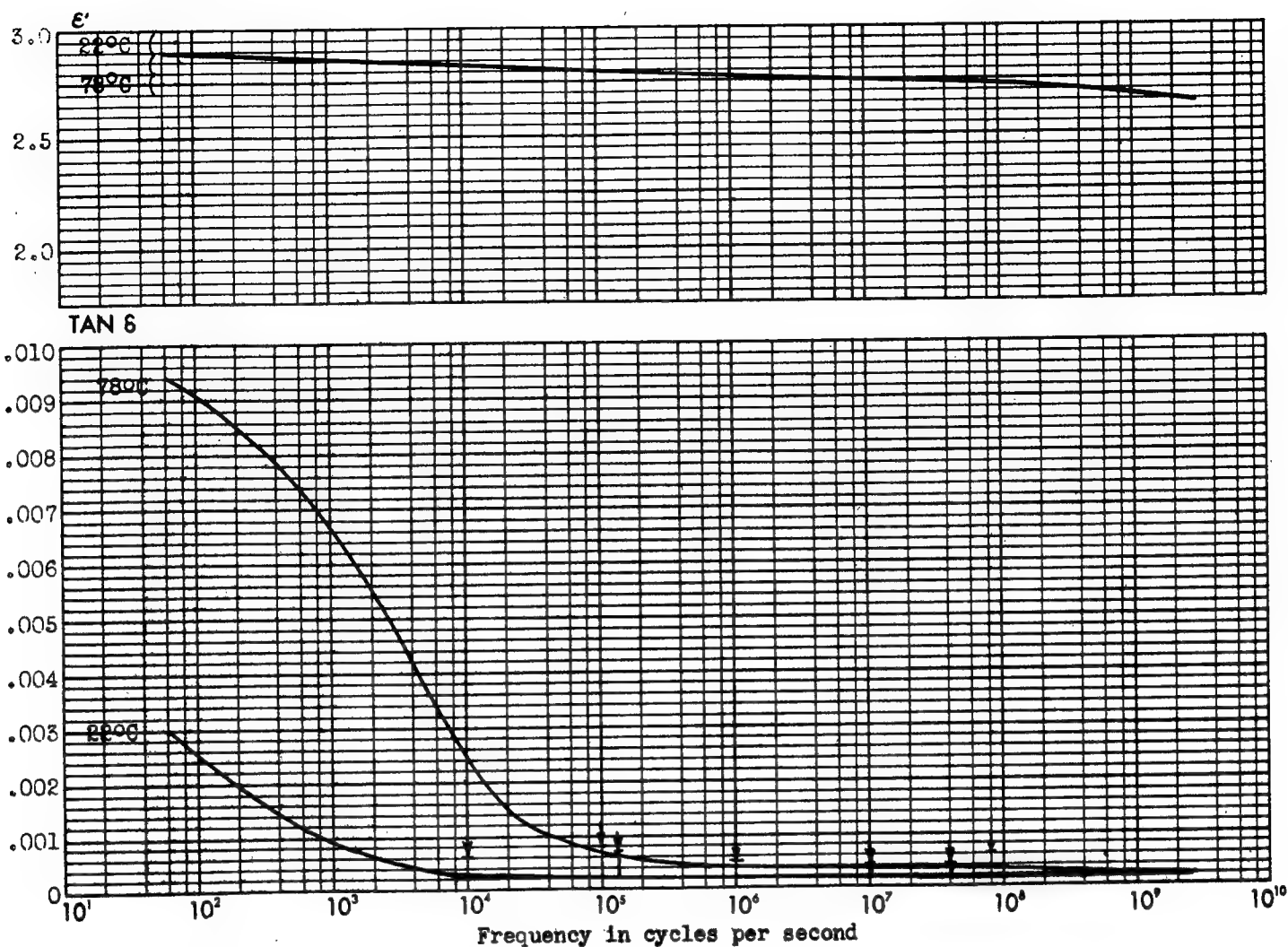
Chemical Name: Polystyrene and glass.

Composition: Polystyrene, Dow Chemical Company's C-176 (17%); glass, Corning's #790 dried at  $500^\circ\text{C}$  (83%).

Properties: Opaque, white.  $d_{25} = 1.83$ . Mach.: very poor, requiring high speed tools. Therm. Exp.  $-20^\circ\text{C}$  to  $25^\circ\text{C}$ ,  $1.1 \times 10^{-5}$ ;  $25^\circ\text{C}$  to  $60^\circ\text{C}$ ,  $1.3 \times 10^{-5}$ .  $T_{\text{dis}} 80^\circ\text{C}$ .  $T_{\text{soft}}$ : high. Moist. Abs. 90% humidity 0.6%.

Method of Handling: Compr. Mold.  $200^\circ\text{C}$ , 10,000.

Recommended Uses: For radio equipment requiring a dielectric of low electrical loss, a thermal expansion coefficient approximately the same as that of copper or brass and a high resistance to the local application of heat.



Chemical Name: Polystyrene and chlorinated diphenyl mixture.

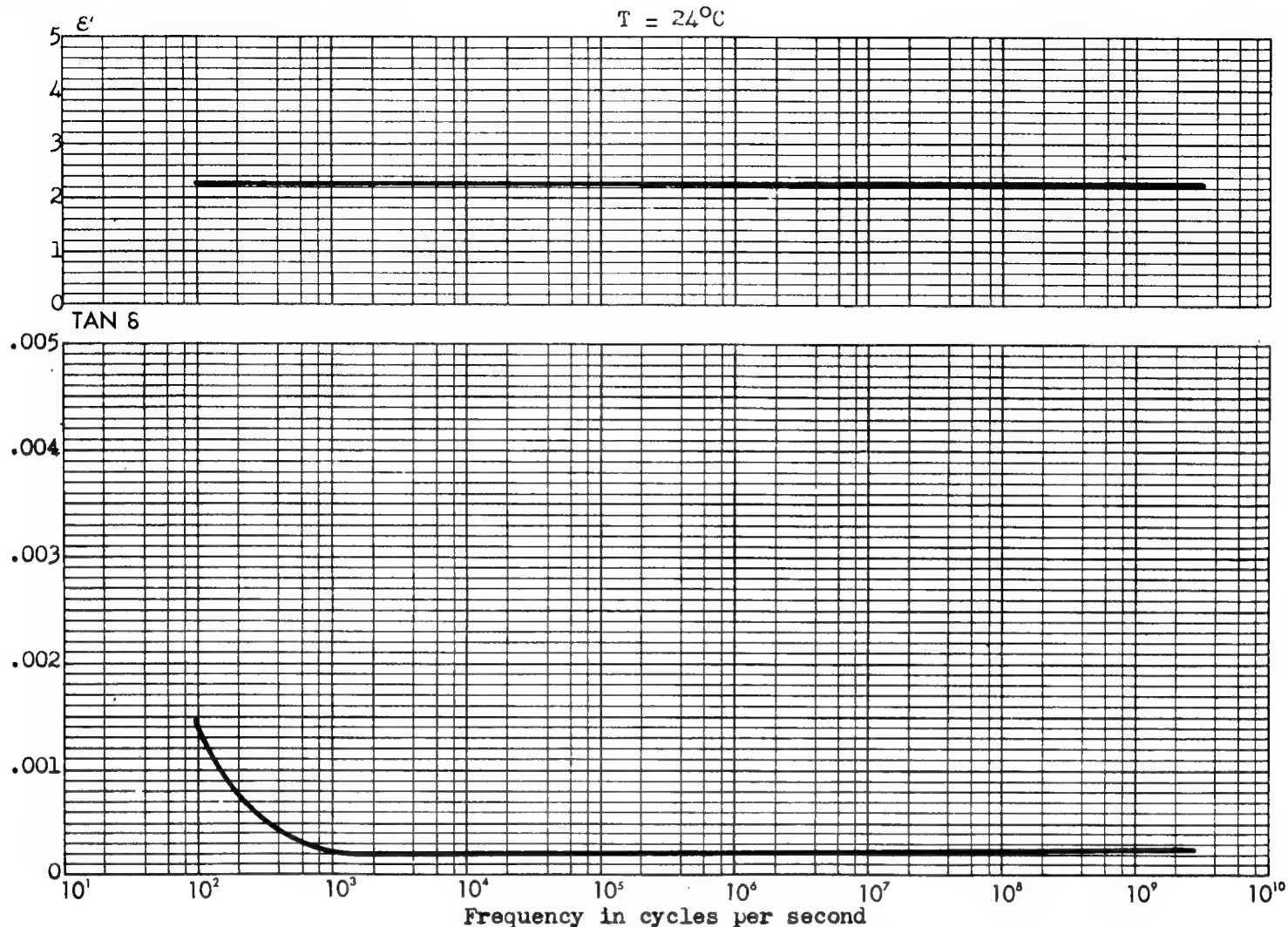
Composition: Linear addition polymer of polystyrene (50%), Aroclor i.e. chlorinated diphenyl (50%) and small amounts of dyestuffs.

Properties: Opaque cream or grey color.  $d^{25}_4=1.358$ . Ten. Str. 3000-3500. Rockwell M72. Imp.(Izod)  $25^\circ\text{C}$  2.59. Mod. El.: Tens.  $3.34 \times 10^5$ ; Compr.  $4.02 \times 10^5$ . Comp. Str. 11,400. Flex. Str.  $25^\circ\text{C}$ , 6540. Elong. 0.97%. Mach.: excellent.  $T_{dis}$  84.5-86.0 $^\circ\text{C}$ . Thermoplastic. Chem. Res.: acids, affected slightly by oxidizing acids; alkalis, excellent; solvents, soluble in aromatic and chlorinated hydrocarbons; water, excellent; oxygen, excellent. Moist. Abs. 0.03%. Flam.: chars only.

Methods of Handling: Compr. Mold. 149-204 $^\circ\text{C}$ , 500-5000; Inj. Mold. 177-232 $^\circ\text{C}$ , 10,000-30,000; Extr. 177-260 $^\circ\text{C}$ .

Recommended Uses: Excellent for high frequency electrical insulation except where unusual high operating temperatures are encountered.

Availability: Can be supplied as powder in commercial production.



Chemical Name: Polyvinylcyclohexane. Sample Designation: 810-8-95.

Composition: Completely hydrogenated linear addition polymer of styrene.

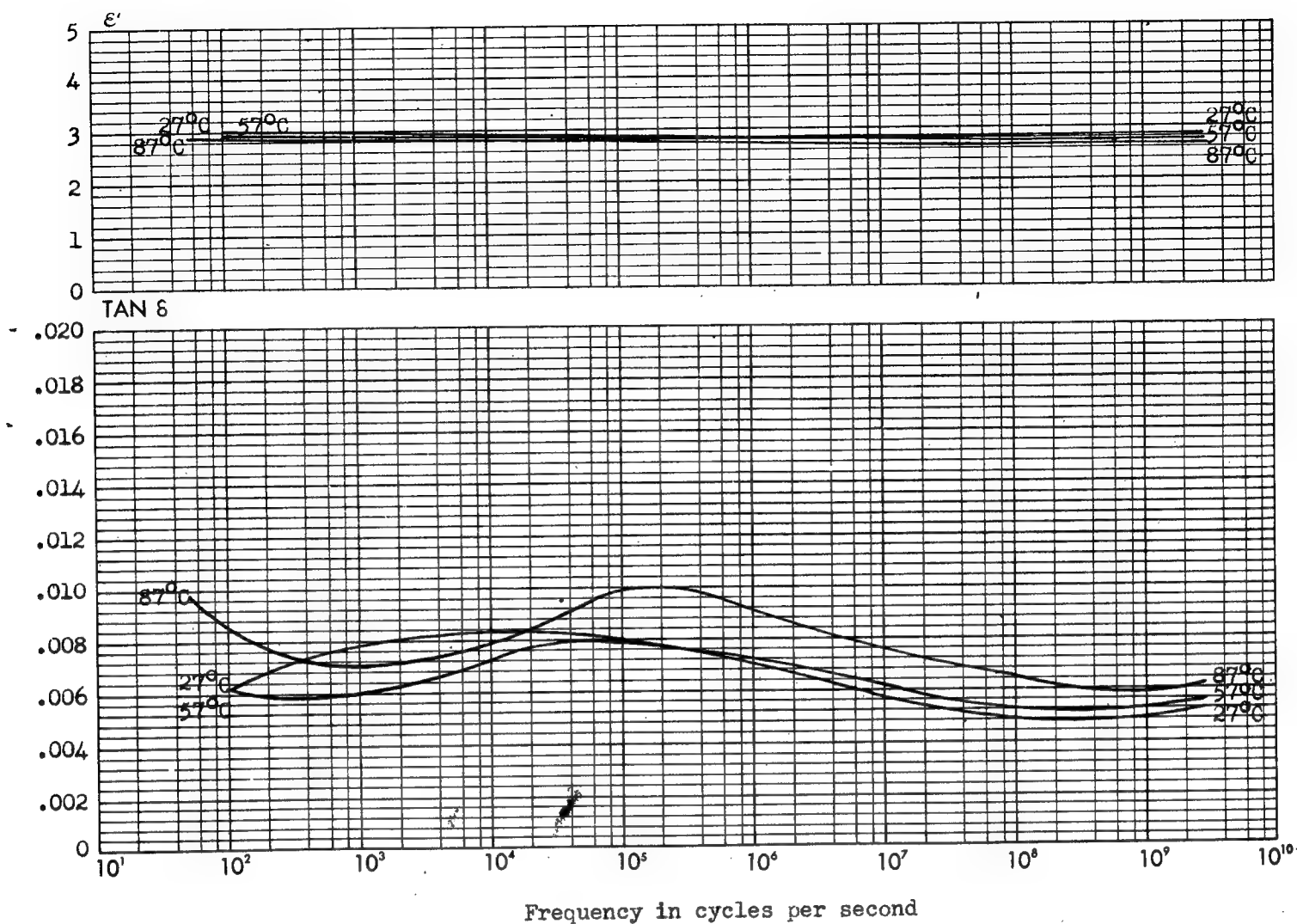
Chemicals Used: Polystyrene A-100, catalyst, hydrogen and solvent.

Properties: Clear, colorless. Ten. Str. 4675 av. Rockwell 94. Imp.(Izod) 0.242.  $T_{dis}$   $99^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: aromatic and chlorinated solvents, poor; water, good.

Methods of Handling: Compr. Mold.  $170^{\circ}\text{C}$ , 2000.

Recommended Uses: Electrical insulation requiring low dielectric constant and high distortion temperature.

Availability: Small experimental quantities.

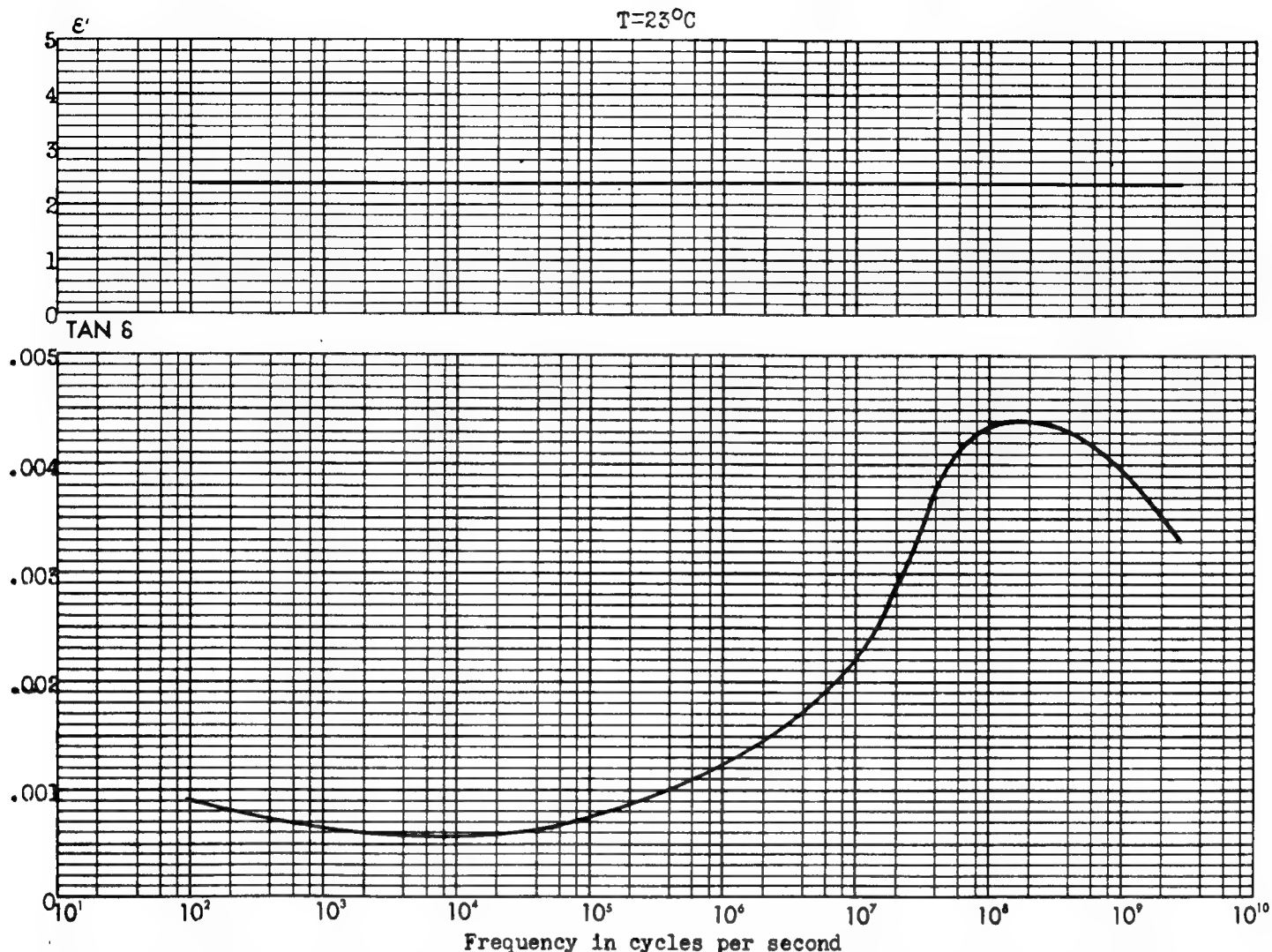


Chemical Name: Polystyrene-vinyl cyanide copolymer.

Composition: Linear addition copolymer of styrene (80%) and vinyl cyanide (20%).

Properties: Clear, colorless.  $d^{25}=1.02$ .  $T_{\text{soft}} 118^{\circ}\text{C}$ .





**Composition:** Under government secrecy order, polymer (99%) with antioxidant (1%).

**Properties:** Blue-gray.  $d^{25}_4 = 0.96$ . Ten. Str. 1000-2000. Shore 70-80.

Imp. (Izod, notch): tough at dry ice temperatures; 25°C, 1.2-1.8. Elong. 200-250% at break. Mach.: good. Spec. Heat 0.41. Vol. Exp.  $1.79 \times 10^{-4}$ , -20 to 84°C.

Tdis 62-65°C. Tsoft 125°C. Thermoplastic. Chem. Res.: acids, good; alkalies, good; aromatic solvents, poor; water, good; oxygen, fair. Sun.: darkens slightly.

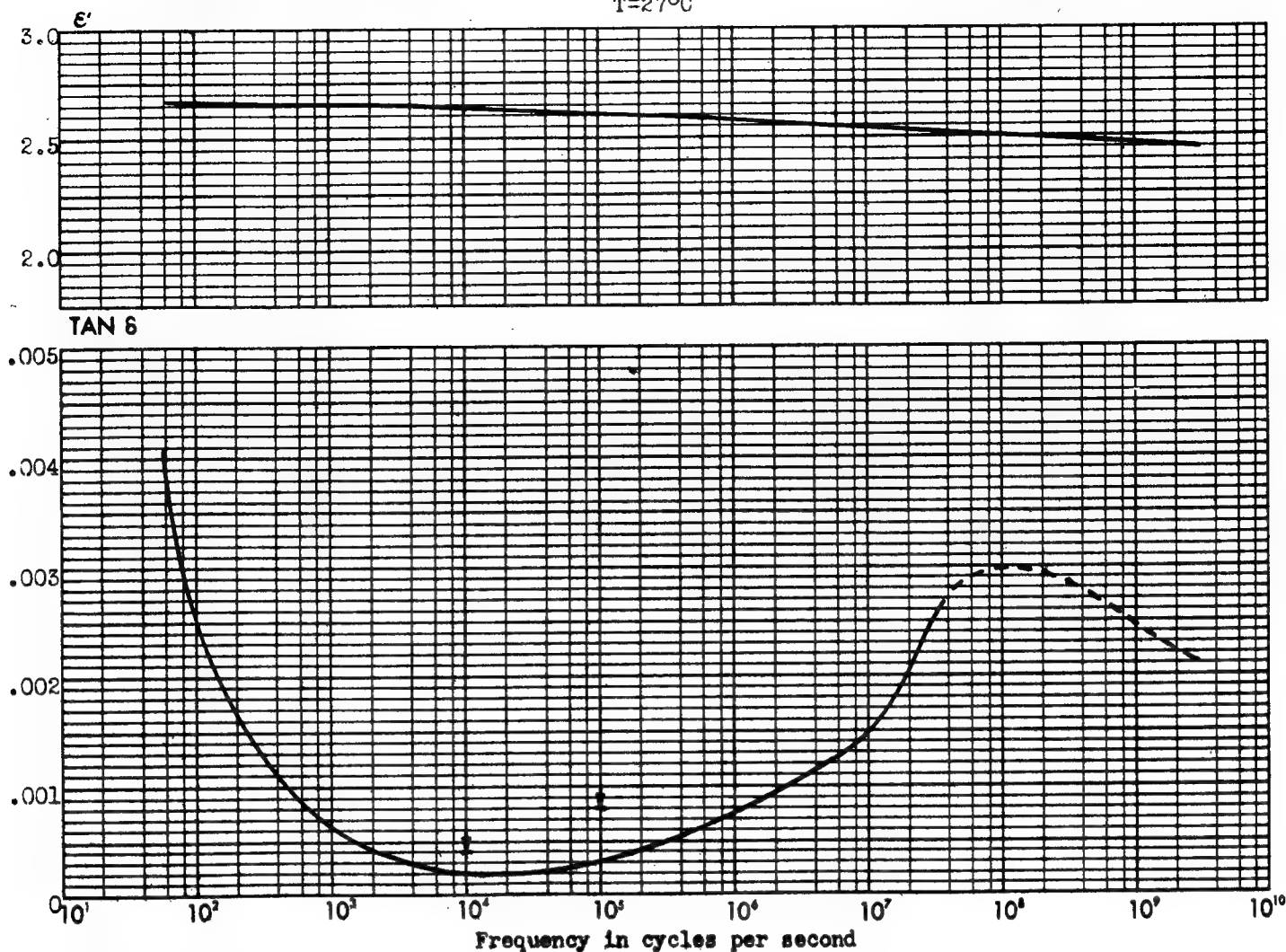
Moist. Abs. 0.2-0.4%. Flam.: 1 in./min.

**Methods of Handling:** Compr. Mold. 120-150°C, 500-1000. Inj. Mold. 190-232°C, 5000-10,000. Extr. 177-196°C.

**Recommended Uses:** For flexible electrical insulation.

**Availability:** Molding powder under allocation.

T=27°C



Composition: Under secrecy order. Polymer (99%); filler (1%). A harder variety of Styraloy 22.

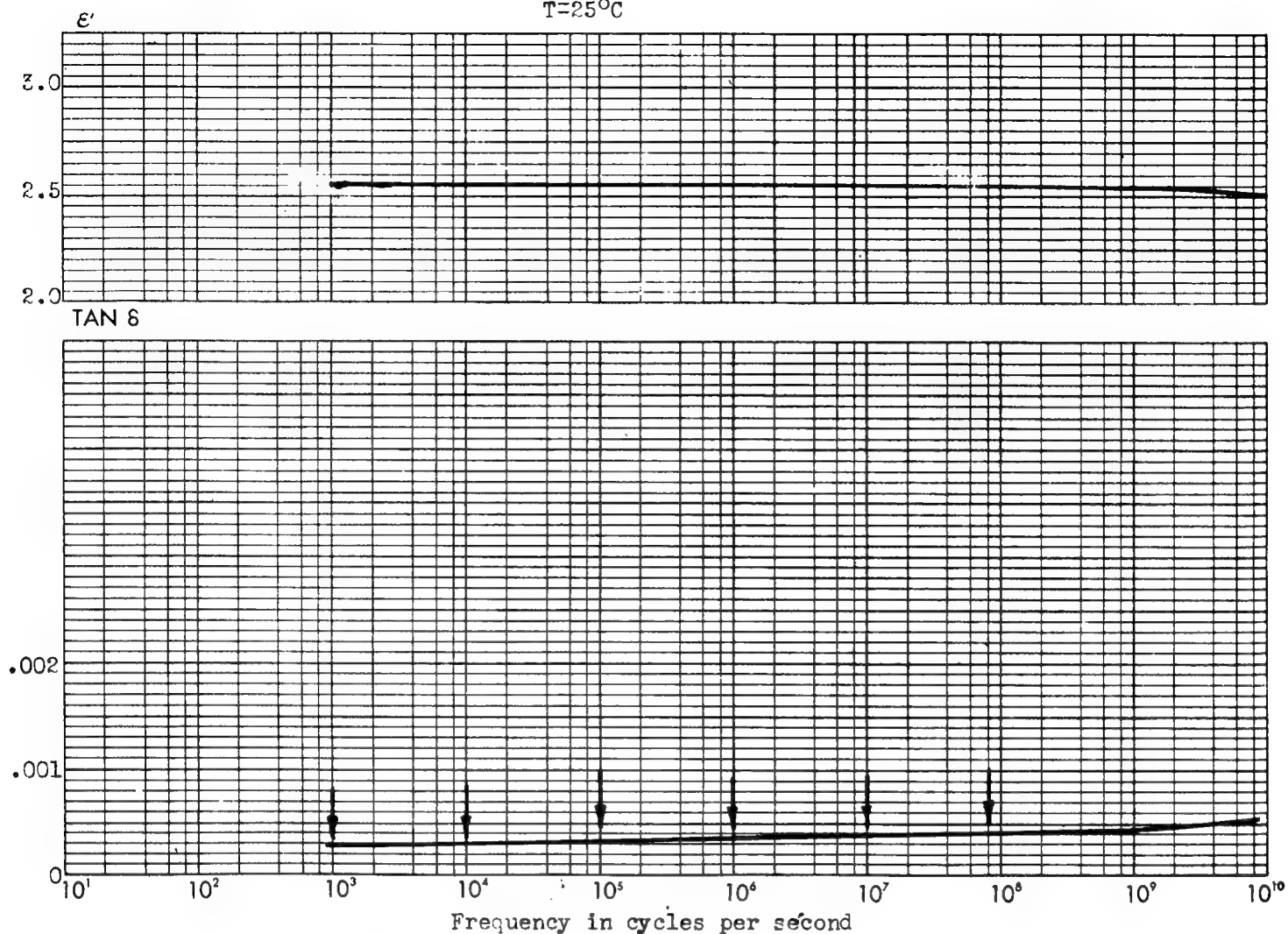
Properties: Blue gray.  $d^{25}=0.965$ . Ten. Str.: 3500-4500 Inj. Mold.; 2500-3000 Compr. Mold. Shore 93-95. Imp.(Izod):  $-40^{\circ}\text{C}$  0.04;  $25^{\circ}\text{C}$  0.02. Flex. Str.(modulus of bending)  $25^{\circ}\text{C}$  168,000-173,000. Elong. 6-12%. Mach.: good. Vol. Exp.:  $4.2 \times 10^{-4}$ ,  $0-80^{\circ}\text{C}$ ;  $6.3 \times 10^{-4}$ ,  $>80^{\circ}\text{C}$ .  $T_{dis}$   $70-80^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: non-oxidizing acids, good; aromatic and chlorinated solvents, poor; water, good; oxygen, fair. Sun.: slight discoloration. Flam.  $1\frac{1}{2}$  in./min. Elec. Str. 2000(10 mils). Arc Res. 240.

Methods of Handling: Compression molding and injection molding possible.

Recommended Uses: Electrical applications requiring a tough rigid material especially adapted to injection molding.

Availability: Molding powder in semi-plant production (facilities being expanded) under allocation.

T=25°C



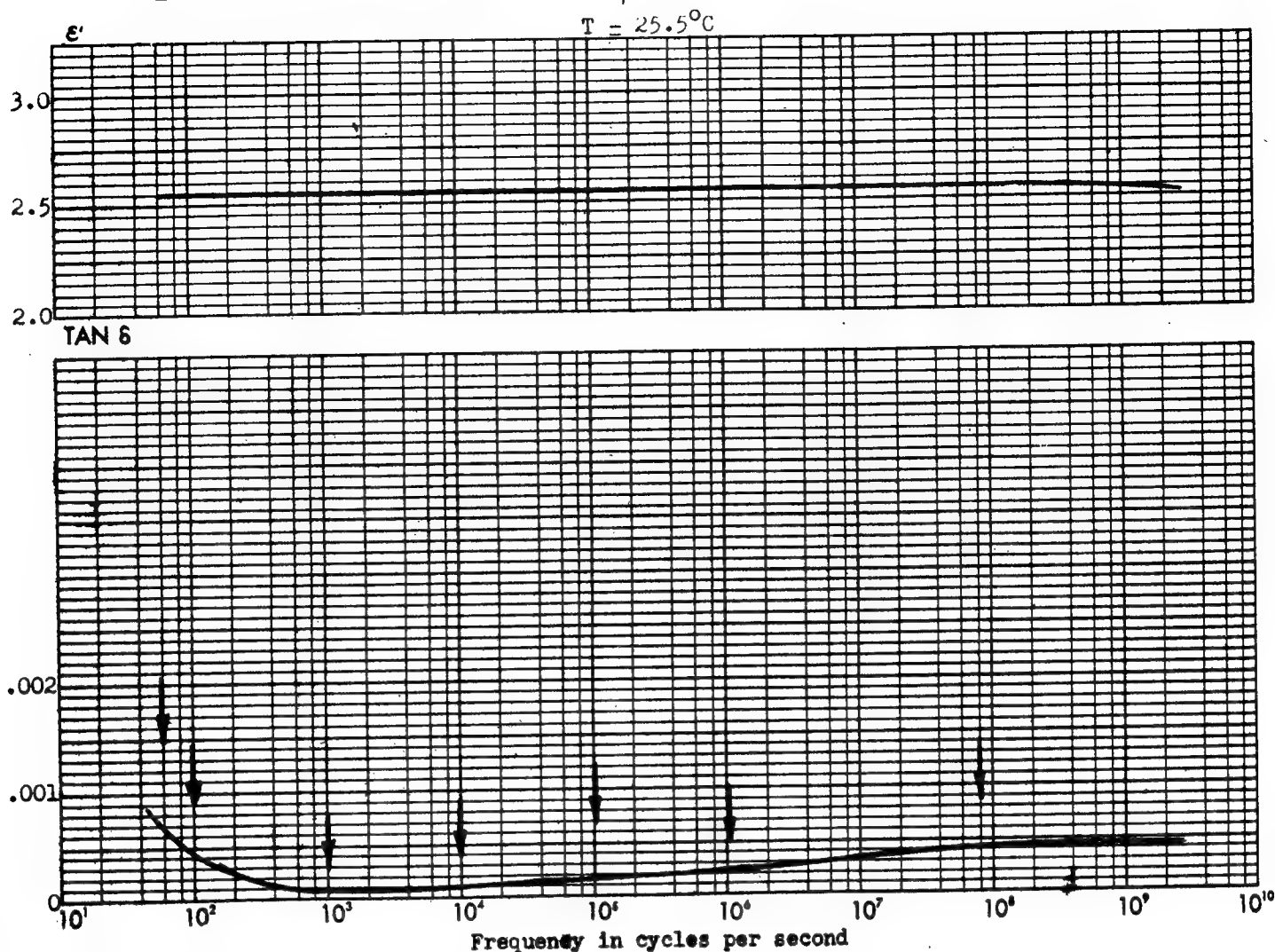
Composition: Cross-linked addition styrene copolymer

Properties: Clear, colorless to pale yellow.  $d^{25}=1.04-1.06$ . Imp.(Dynstat) 0.07-0.08. Flex. Str.(Dynstat) 7500-10,000. Mach.: good. Thermosetting. Chem. Res.: aromatic hydrocarbons, poor; water, excellent. Moist. Abs. <0.1%.

Recommended Use: Substitute for polystyrene. It has improved machining qualities and does not flow at elevated temperatures.

Method of Handling: Machining from castings.

Availability: Rods and sheets in commercial production.



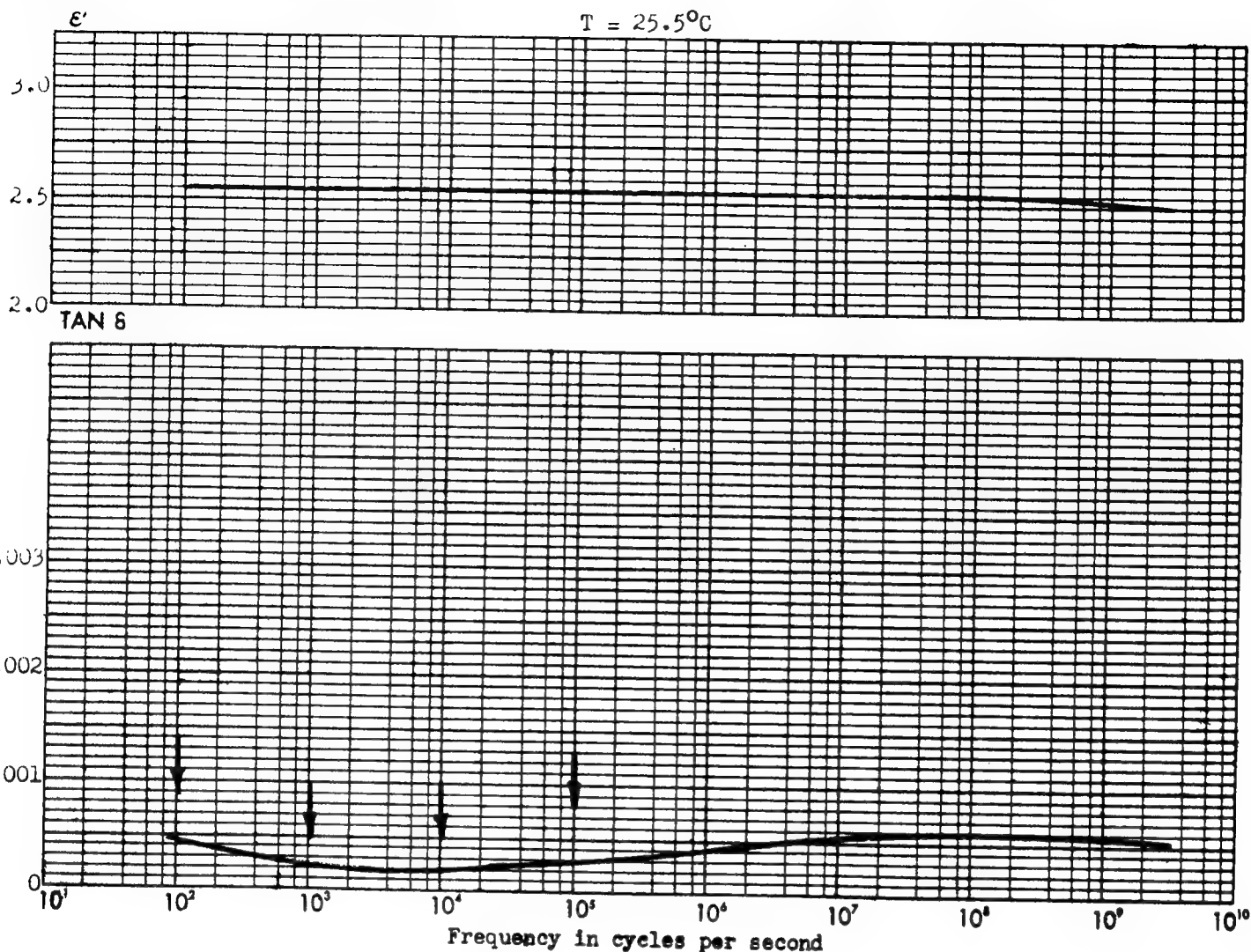
Composition: Cross-linked addition styrene copolymer (100%).

Properties: Water white.  $d_{20}^{20} = 1.05$ . Ten. Str. 5000. Rockwell M95. Imp. (Izod) 0.125-0.166. Elong. 3%. Mach.: excellent.  $T_{dis} 100^{\circ}\text{C}$ . Therm. Sta.: excellent. Thermosetting. Chem. Res.: oxidizing acids, poor; other acids, good; alkalies, good; solvents, excellent; water, excellent. Sun.: very slight discoloration. Moist. Abs.: probably low. Arc Res.: slightly better than polystyrene.  $n_D = 1.59$ .

Methods of Handling: Machining, grinding, hot forming and bending at  $150^{\circ}\text{C}$  with limited deformation.

Recommended Uses: Electrical applications at elevated temperatures.

Availability: Rods  $1/4"$  to  $1/2"$  diameter up to 12" long in semiplant quantities.



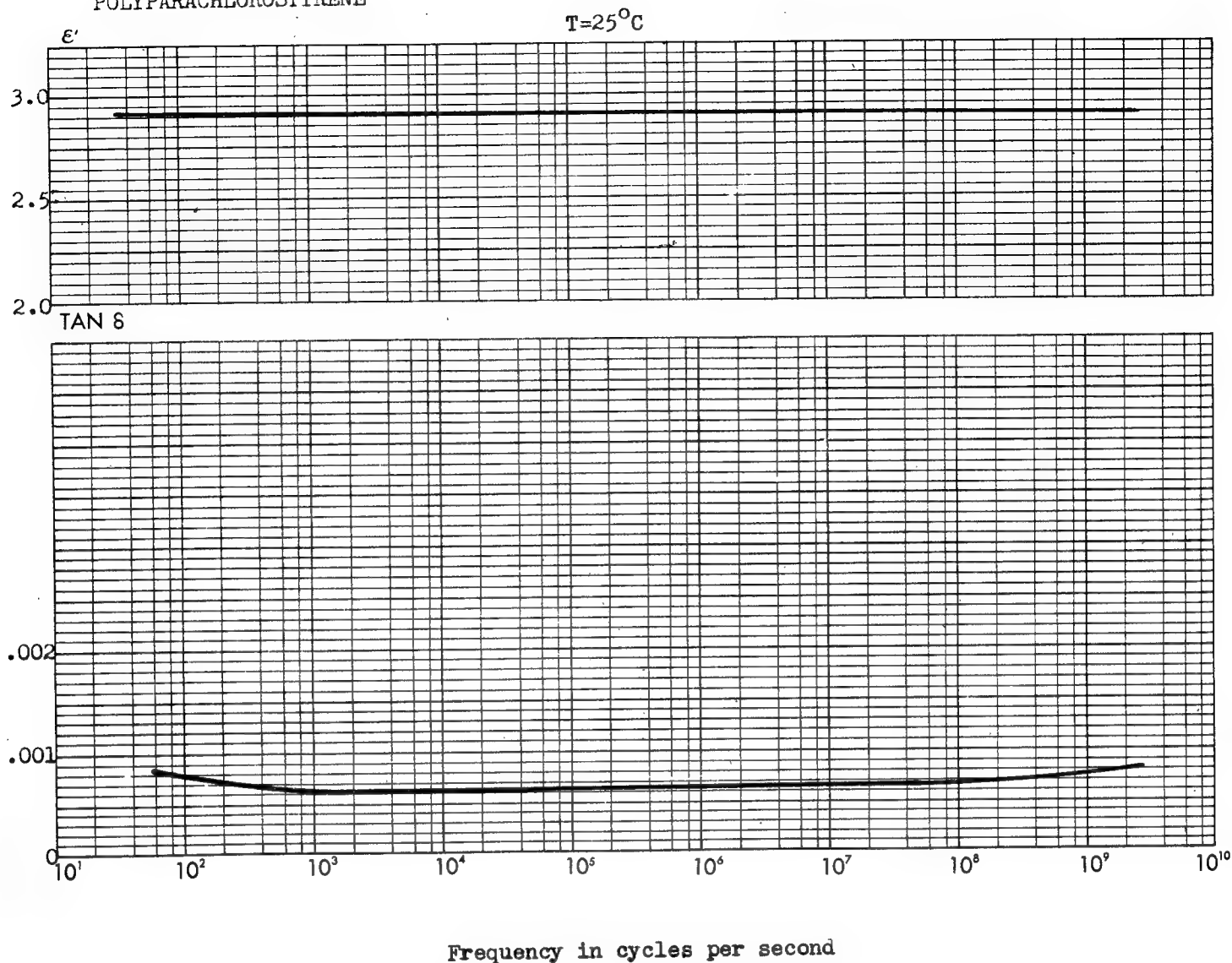
Composition: Cross-linked addition copolymer of styrene (100%).

Properties: Water white.  $d^{20}_4 = 1.05$ . Ten. Str. 1300-1900. Rockwell M94. Imp.(Izod) 0.083-0.125. Mach.: good.  $T_{dis}$  110-115°C. Therm. Sta.: excellent. Thermosetting. Chem. Res.: oxidizing acids, poor; other acids, good; alkalies, good; solvents, excellent; water, excellent. Sun.: very slight discoloration. Moist. Abs.: probably low. Arc Res.: slightly better than polystyrene.

Methods of Handling: Machining, grinding, hot forming and bending at 150°C with limited deformation.

Recommended Uses: Electrical applications at elevated temperatures.

Availability: Rods 1/4" to 1/2" diameter up to 12" long in semiplant quantities.



Chemical Name: Polyparachlorostyrene. Sample Designation: D366

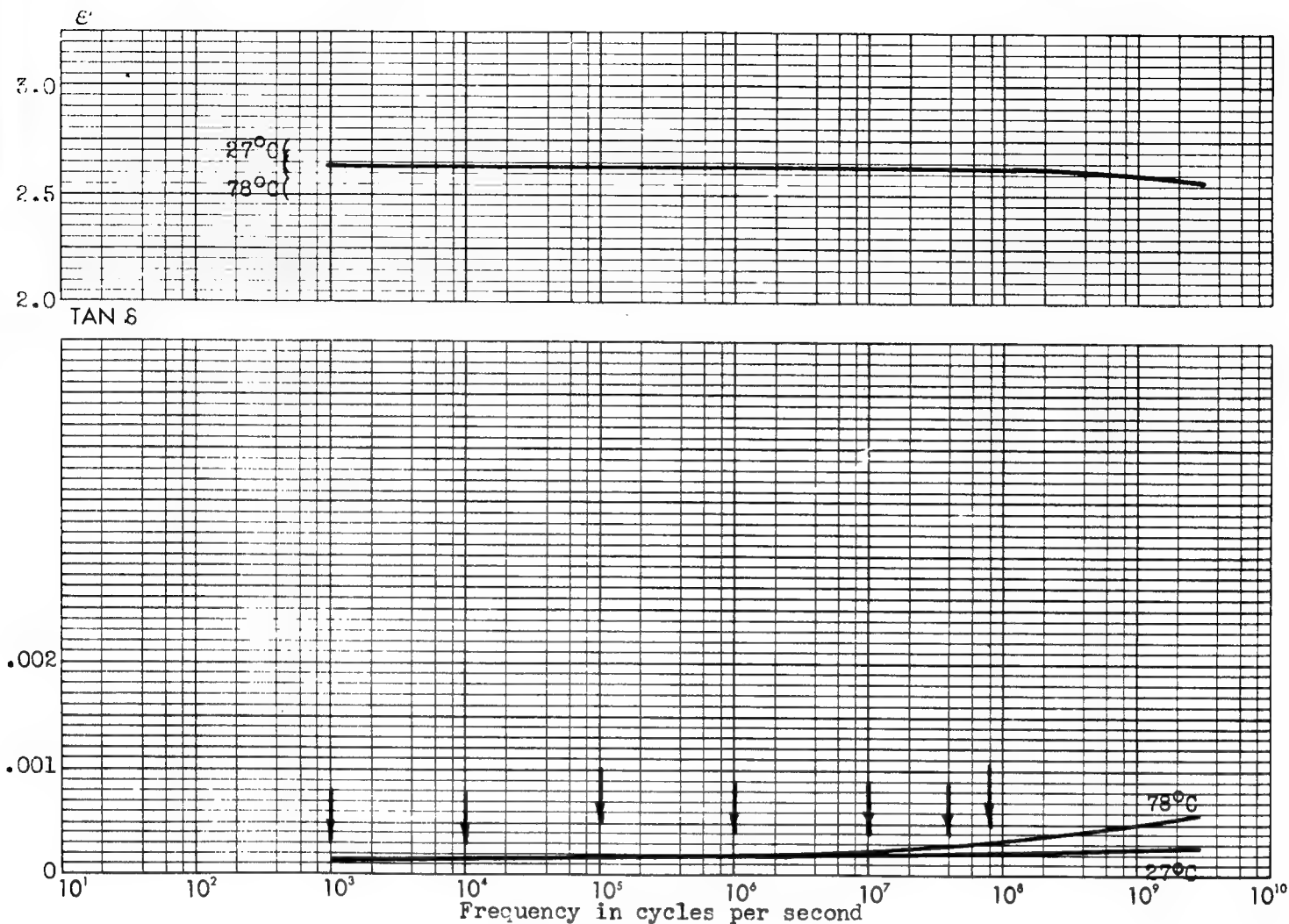
Composition: Linear addition polymer of polyparachlorostyrene 98%(2% non-polymerizables).

Properties: Clear and colorless.  $d^{25}=1.23$ . Rockwell M95.5.  $T_{dis}$   $108^{\circ}\text{C}$ .  
Thermoplastic. Flam.: self-extinguishing.

Methods of Handling: Cast.  $75-105^{\circ}\text{C}$ , 1-4 days. Compr. Mold.  $175-200^{\circ}\text{C}$ , 2000-5000.  
Inj. Mold.  $240-270^{\circ}\text{C}$ , 10,000-30,000. Extr.: about  $260^{\circ}\text{C}$ .

Recommended Uses: High frequency insulation.

Availability: Laboratory quantities.



Chemical Name: Poly2, 5-dichlorostyrene

Sample Designation: Research Sample Nos. D-517, D-1026, D-1286, D-1385 (data averaged).

Composition: Linear addition polymer of 2,5-dichlorostyrene (99.0%) and unpolymerized materials (1%).

Properties: Colorless to very slightly yellow.  $d^{25}_4=1.35$ . Rockwell M100.

Mach.: fair.  $T_{dis}$  113°C. Thermoplastic. Moist. Abs. 0.03%. Flam.: self-extinguishing.

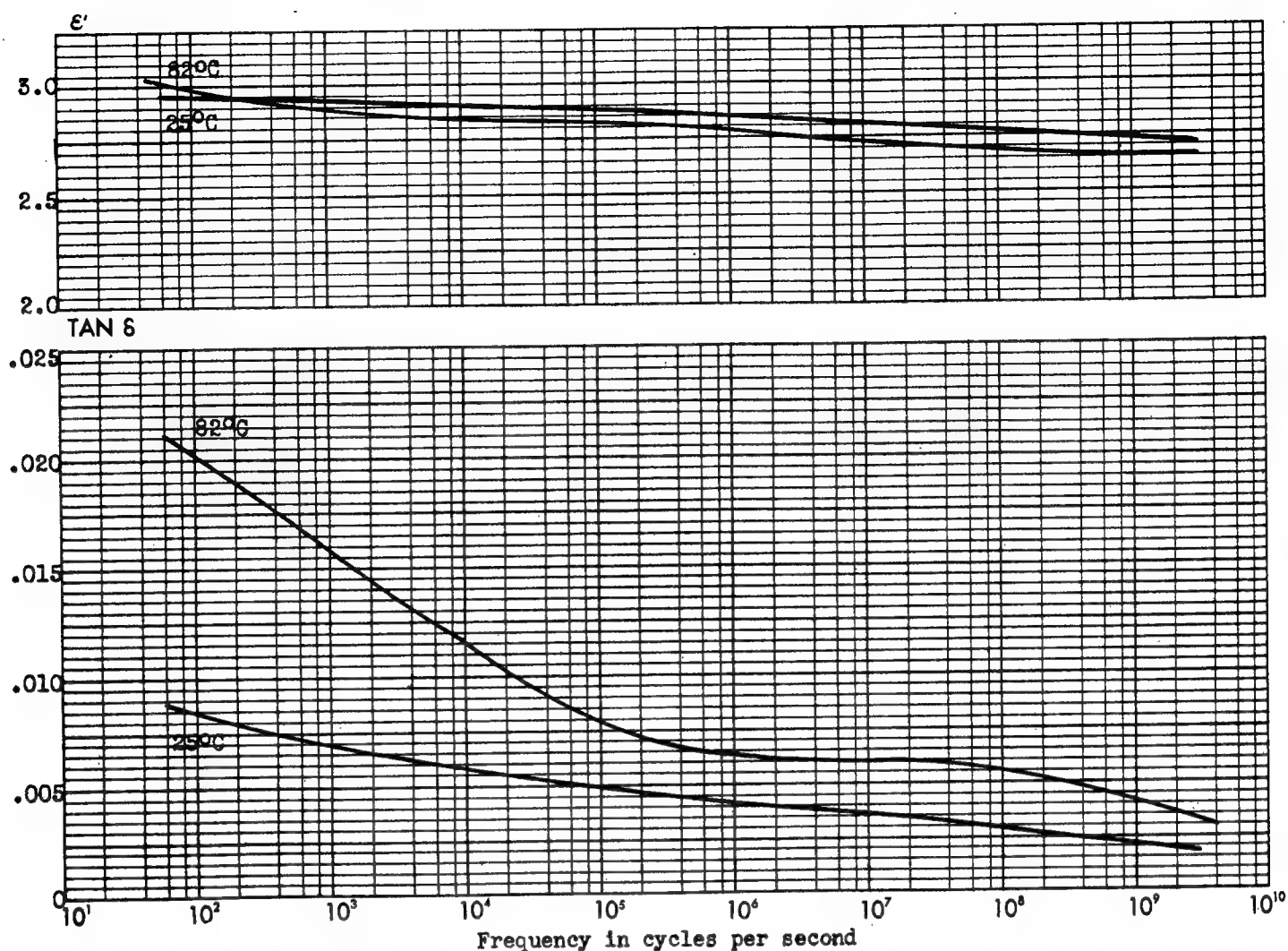
Methods of Handling: Cast. 50-150°C, 1 to 3 days. Compr. Mold. 175-200°C, 1000-5000.

Inj. Mold. 450-550°C, 10,000-30,000.

Recommended Uses: Electrical apparatus.

Availability: Pilot plant quantities.





Chemical Name: Poly 3,4-dichlorostyrene Sample Designation: Res. Samples D-950, D-951.

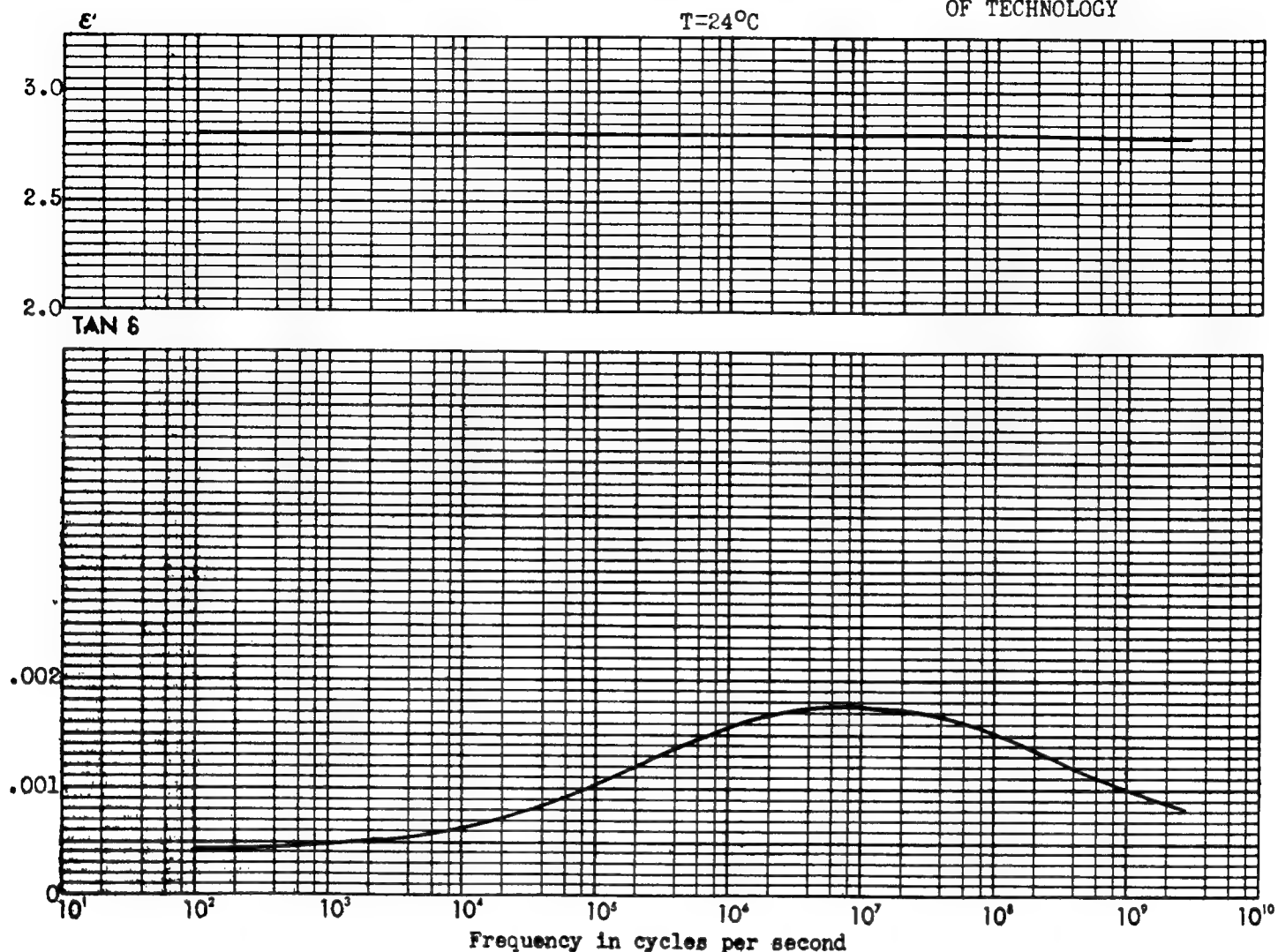
Composition: Linear addition polymer of 3,4-dichlorostyrene (95%) and unpolymerized materials (5%).

Properties: Colorless to very slightly yellow.  $T_{dis}$  103°C. Thermoplastic.

Recommended Uses: Electrical apparatus.

Availability: Laboratory samples only.





Chemical Name: Polystyrene-vinyl carbazole copolymer.

Composition: Linear addition copolymer of styrene (20%) and vinyl carbazole (80%).

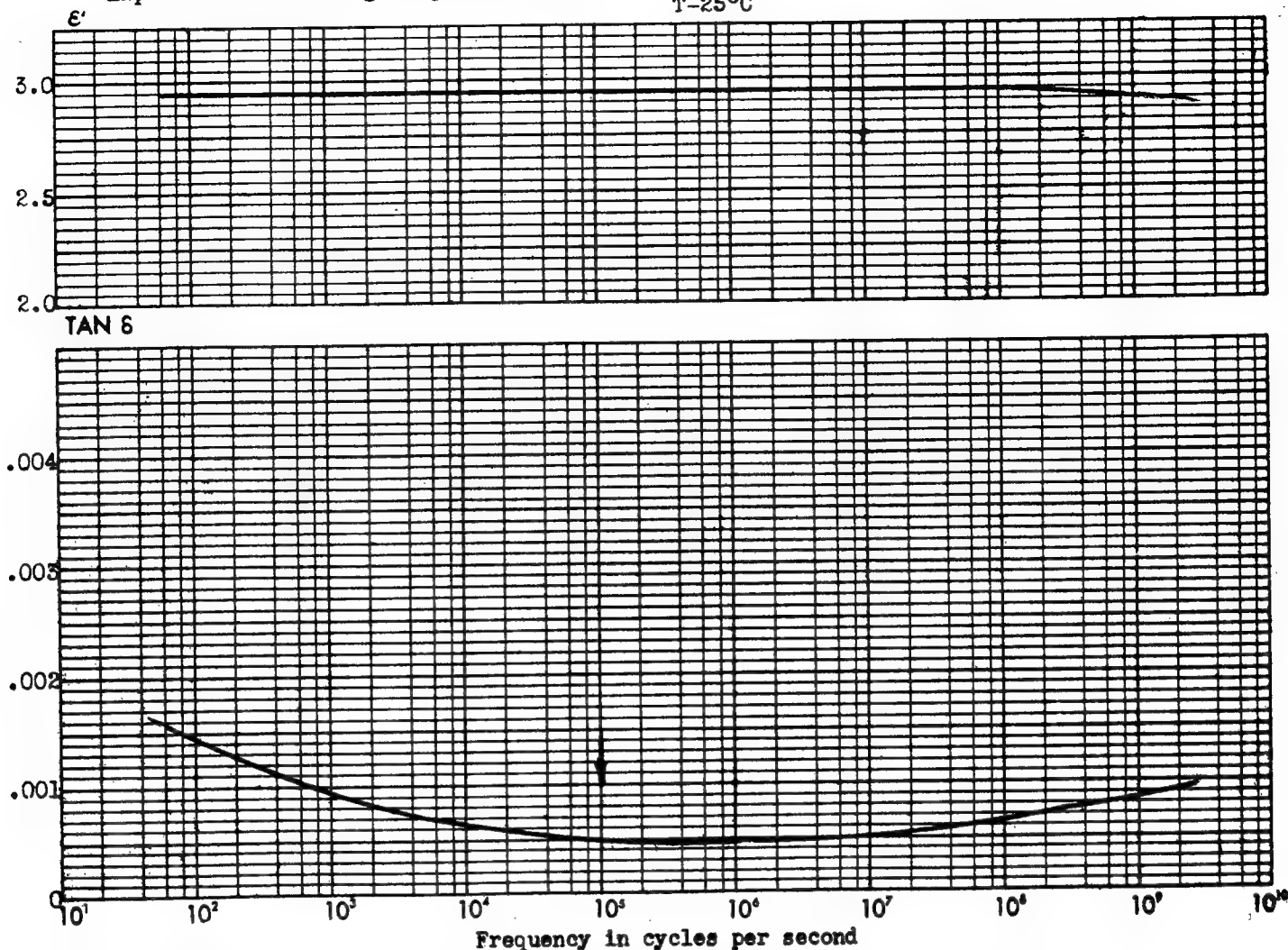
Properties: Opaque, white.  $d^{25}=1.14$ . Brittle. Therm. Exp.  $-20^{\circ}\text{C}$  to  $25^{\circ}\text{C}$ ,  $5.6 \times 10^{-5}$ ;  $25^{\circ}\text{C}$  to  $60^{\circ}\text{C}$ ,  $5.6 \times 10^{-5}$ .  $T_{\text{dis}} 127^{\circ}\text{C}$ .  $T_{\text{soft}} 190^{\circ}\text{C}$ . Therm. Sta.: becomes yellow on surface at elevated temperatures.

Method of Handling: Compr. Mold.  $200^{\circ}\text{C}$ , 2500.

Recommended Use: High temperature electrical insulators in which brittleness does not impair usefulness.

Experimental Molding Composition No. 24

T=25°C



Chemical Name: Polyvinyl carbazole Sample Designation: M596

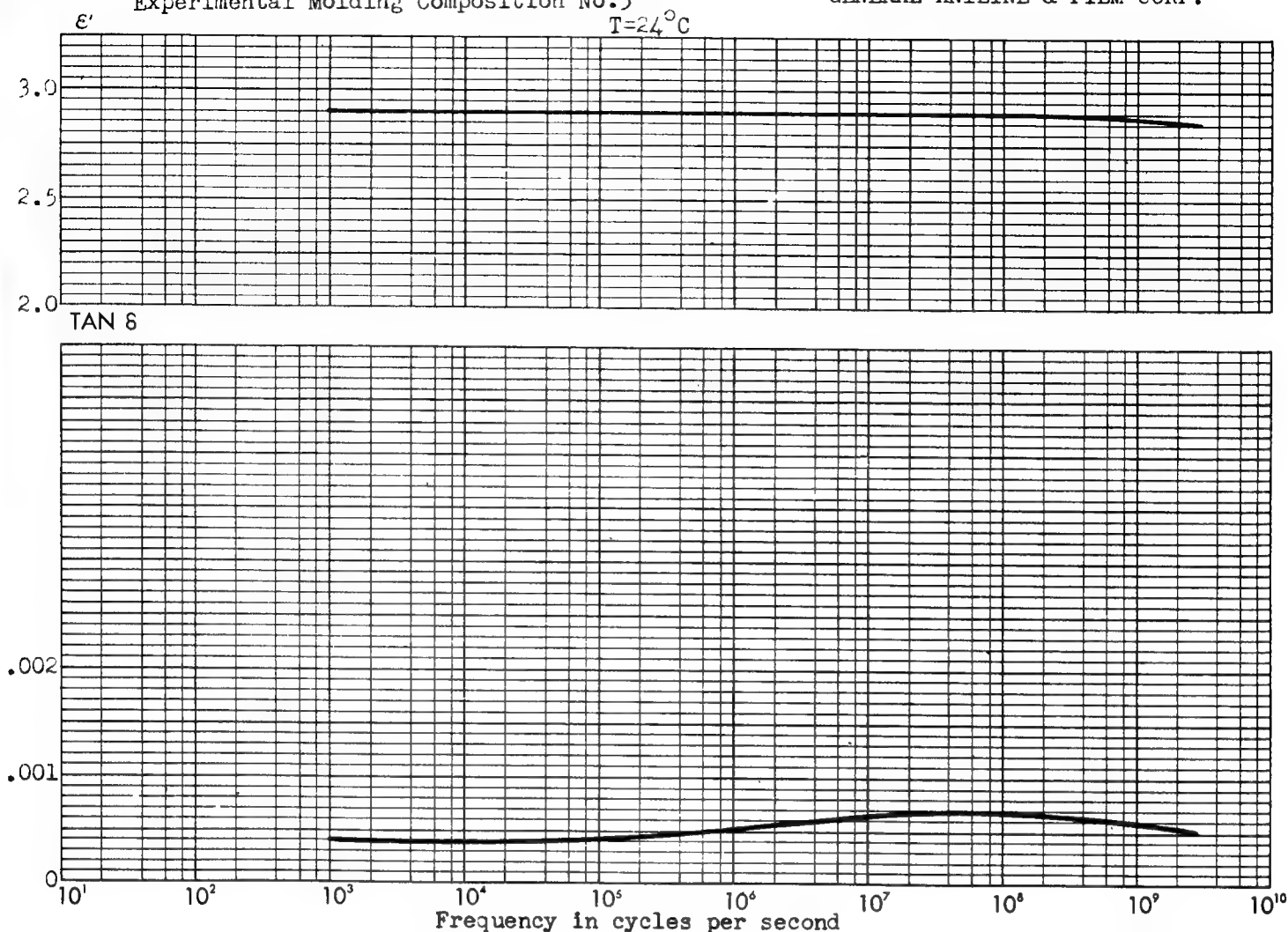
Composition: Linear addition polymer of vinyl carbazole (98.7%) with HB 40 oil (1.3%) as plasticizer.

Properties: Grey to light brown, opaque.  $d^{25}=1.19$ . Rockwell M70-90. Imp. (Izod, modified) 0.5-1.0, 25°C. Flex. Str.: 4500-5500 at -20°C, 25°C and 80°C. Elong.: low. Mach.: good. Spec. Heat 0.3. Therm. Exp.  $4.5-5.5 \times 10^{-5}$ .  $T_{dis}$  150-160°C (modified compositions range from 100-150°C).  $T_{soft}$  200°C. Therm. Sta.: no apparent change in properties at 125°C, discolors on long heating above 160°C in air. Thermoplastic, but should not be remolded. Chem. Res.: dilute acids and HF, excellent; conc.  $H_2SO_4$  and conc.  $HNO_3$ , poor; alkalis, good; aromatic and chlorinated hydrocarbons, esters and ketones, poor; aliphatic and hydroaromatic hydrocarbons and alcohols, good; water, good; oxygen, good. Sun.: slight discoloration. Moist. Abs. 0.10% (48 hrs. immersion on thin discs). Flam.: flammable. Elec. Str. 800-1000. Surf. Res.  $10^{14}-10^{16}$ .

Methods of Handling: Compr. Mold.: cycle 10 min. heating and 10 min. molding at 220-240°C (for 1.5" diam. x 0.05" thick discs) and cooling to 150°C under pressure of 1000-4000. Material physically modified by excessive heating.

Recommended Uses: Recommended where good electrical properties and high heat distortion are required in machined or compression molded parts, e.g. high quality sheets, tubes, coil forms, sockets, rods, coaxial cable insulators, etc.

Availability: For laboratory experimentation.



Chemical Name: Polyvinyl carbazole and plasticizer. Sample Designation: EX-5

Composition: Linear addition polymer of vinyl carbazole (90%) with HB 40 oil (10%) as plasticizer.

Properties: Grey to light brown, opaque.  $d^{25}=1.2$ . Imp.(Izod, modified) 0.1-0.2,  $25^{\circ}\text{C}$ . Flex. Str.: 1000-2500 at  $-20^{\circ}\text{C}$ ,  $25^{\circ}\text{C}$  and  $80^{\circ}\text{C}$ . Elong.: low. Mach.: fair. Spec. Heat 0.3. Therm. Exp.  $6-8 \times 10^{-5}$ .  $T_{\text{dis}}$  110-120 $^{\circ}\text{C}$  (modified compositions range from 100-150 $^{\circ}\text{C}$ ).  $T_{\text{soft}}$ : becomes sticky at 175-190 $^{\circ}\text{C}$ . Therm. Sta.: no apparent change in properties at 125 $^{\circ}\text{C}$ , discolors on long heating to 160 $^{\circ}\text{C}$  in air. Thermoplastic. Chem. Res.: dilute acids and HF, excellent; conc.  $\text{H}_2\text{SO}_4$  and conc.  $\text{HNO}_3$ , poor; alkalies, good; aromatic and chlorinated hydrocarbons, esters and ketones, poor; aliphatic and hydroaromatic hydrocarbons and alcohols, good; water, good; oxygen, good. Sun.: slight discoloration. Moist. Abs. 0.10% (48 hrs. immersion on thin discs). Flam.: flammable. Elec. Str. 1000. Surf. Res. 10 $^{14}$ -10 $^{16}$ .

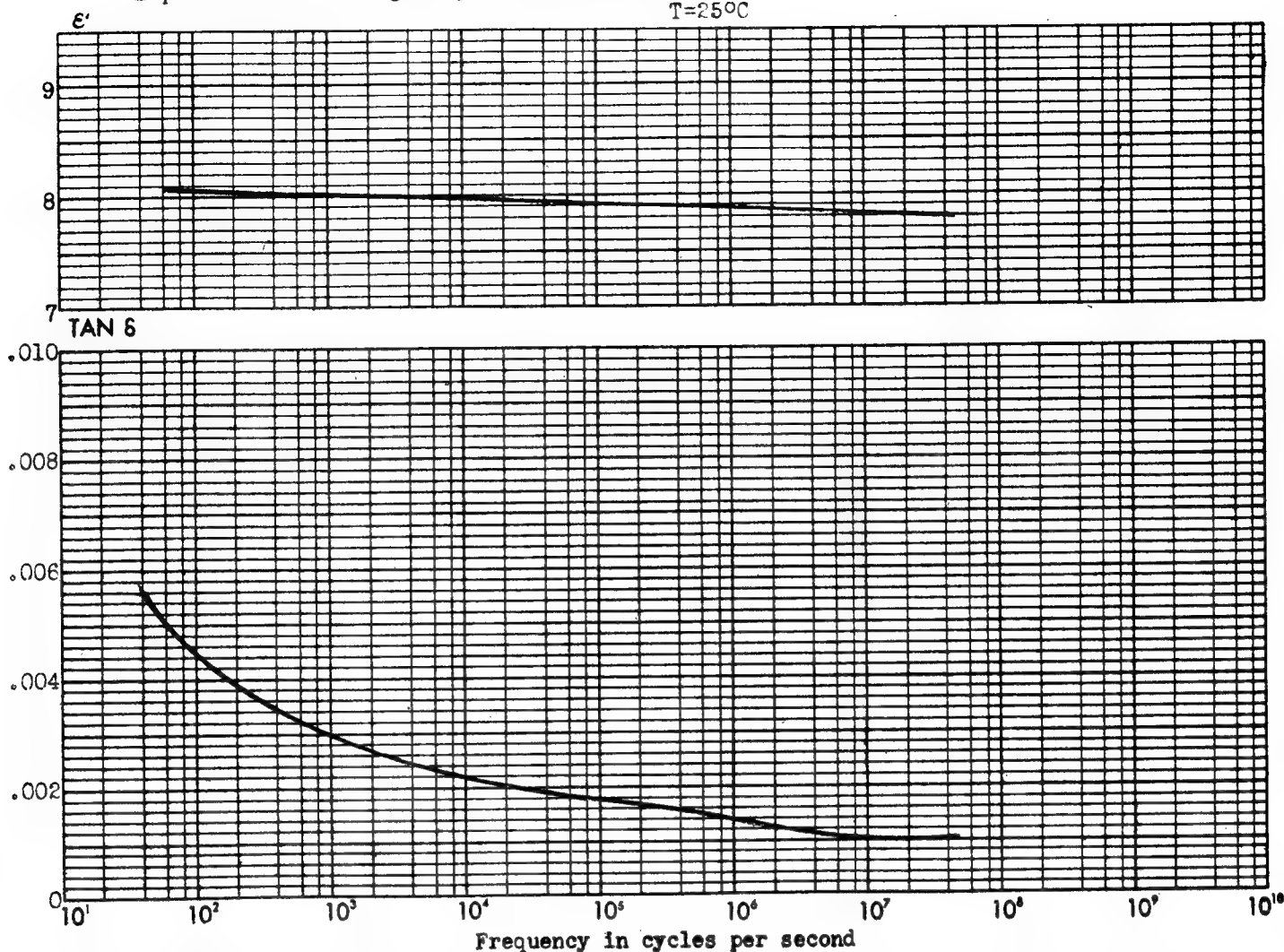
Methods of Handling: Compr. Mold.: cycle 10 min. heating and 10 min. molding at 170-200 $^{\circ}\text{C}$  (for 1.5" diam. x 0.05" thick discs) followed by cooling to 120 $^{\circ}\text{C}$  under pressure of 1000-4000; Inj. Mold. 280-350 $^{\circ}\text{C}$ , 2000-10,000; Extr. 225-250 $^{\circ}\text{C}$ .

Recommended Uses: Injection or compression moldings where excellent electrical properties and high heat distortion temperature are needed and brittleness is not too important, i.e. rods, plates, tubes, coil forms, etc.

Availability: Available for evaluation.

Experimental Molding Composition No.27

T=25°C



Chemical Name: Polyvinyl carbazole Sample Designation: M604

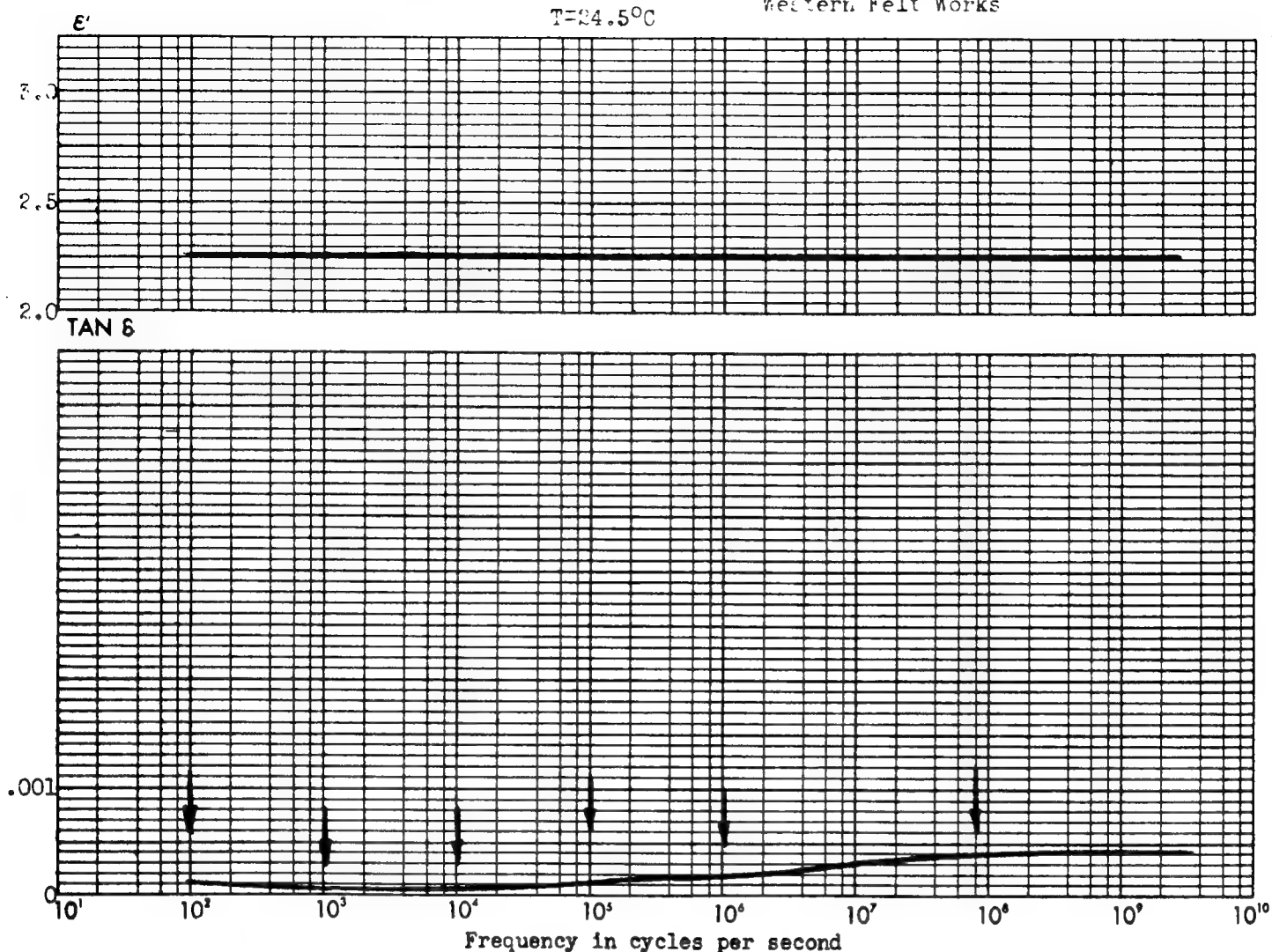
Composition: Linear addition polymer of vinyl carbazole (38%) and filler (60%) with HB 40 oil (2%) as plasticizer.

Properties: Grey to light brown, opaque.  $d_{25}^{25}=2.2$ . Rockwell >M80. Imp.(Izod, modified) 0.16-0.2. Mod. El.  $4-5 \times 10^5$ . Flex. Str. 1000-2500 at  $-20^\circ\text{C}$ ,  $25^\circ\text{C}$  and  $80^\circ\text{C}$ . Elong.: low. Mach.: not good. Therm. Exp.  $3-4 \times 10^{-5}$ .  $T_{dis}$   $150-160^\circ\text{C}$  (modified compositions range from  $100-150^\circ\text{C}$ ).  $T_{soft}$ : becomes sticky at  $220^\circ\text{C}$ . Therm. Sta.: no apparent change in properties at  $150^\circ\text{C}$ . Thermoplastic. Chem. Res.: dilute acids, excellent; conc.  $\text{H}_2\text{SO}_4$  and conc.  $\text{HNO}_3$ , poor; aromatic and chlorinated hydrocarbons, esters and ketones, poor; aliphatic and hydroaromatic hydrocarbons and alcohols, good; water, good; oxygen, good. Sun.: discolors. Flam.: slow burning.

Methods of Handling: Compr. Mold.: cycle 10 min. heating and 10 min. molding at  $240-270^\circ\text{C}$ , 1000-4000; Inj. Mold.: ca.  $300^\circ\text{C}$ , 200-10,000; Extr.  $290-320^\circ\text{C}$ . Compositions with lower molding temp. and  $T_{dis}$  can be obtained.

Recommended Uses: Injection or compression moldings where high dielectric constant, high heat distortion temperature and very low dielectric losses at high frequencies are needed and brittleness is not too important, i.e. rods, plates, tubes, etc.

Availability: Available for evaluation.



Chemical Name: Polyethylene

Composition: Linear addition polymer of ethylene (97%) with stabilizer (3%).

Properties: Milky white.  $d^{25}=0.92$ . Ten. Str. 1800. Shore 95-100. Elong. 600%.

Mach.: fair. Spec. Heat 0.53. Therm. Exp.:  $>115^\circ\text{C}$ ,  $25 \times 10^{-5}$ ;  $<115^\circ\text{C}$  varies.

Therm. Cond.:  $0-15^\circ\text{C}$ ,  $1.66 \times 10^{-3}$ ;  $25-40^\circ\text{C}$ ,  $1.37 \times 10^{-3}$ .  $T_{\text{dis}}$  95-105 $^\circ\text{C}$ .

Therm. Sta.:  $\approx 75^\circ\text{C}$ . Thermoplastic. Chem. Res.: acids, good; alkalies, good;

solvents, good; water, good; oxygen, good. Sun.: slight. Moist. Abs. 0.03%.

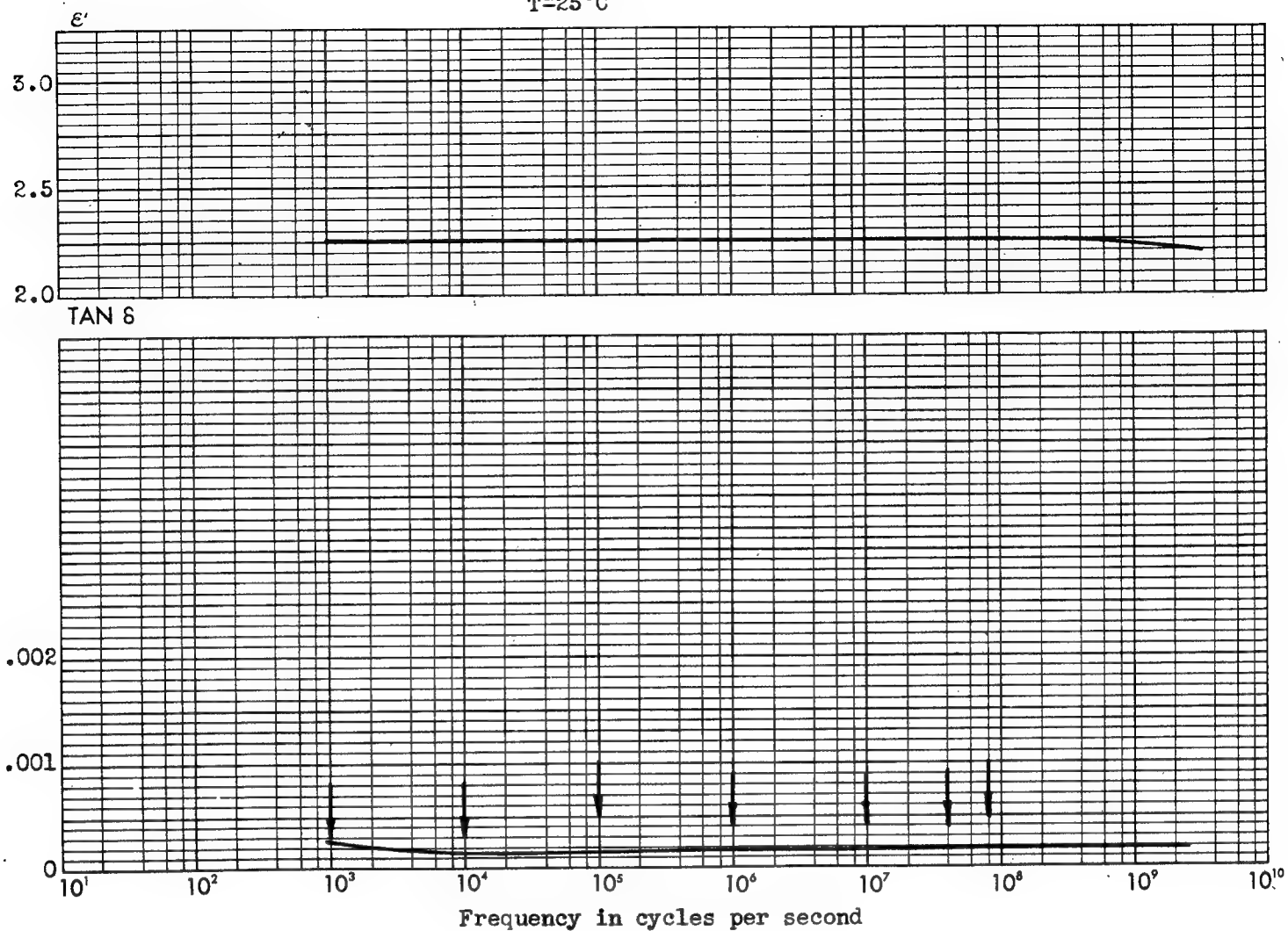
Flam.: slow burning.

Methods of Handling: Compression molding and extrusion possible.

Recommended Uses: Cable insulation, gaskets, etc.

Availability: Sheets, tubes and coated wire under strict allocation.

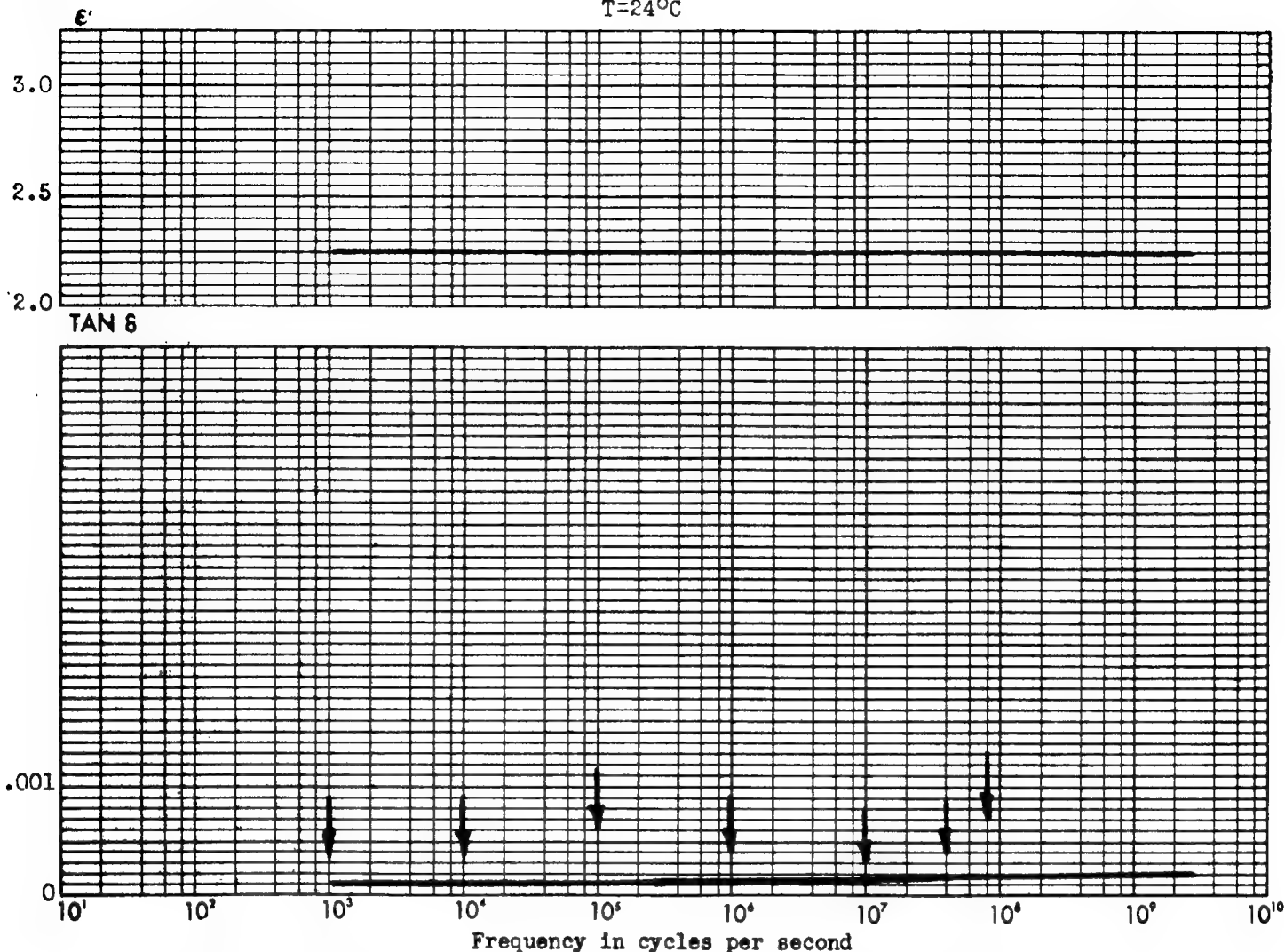
T=25°C



NOTE: In the absence of specific information regarding the properties of Polyethylene M 702-R, refer to Polyethylene KLV manufactured by E. I. Du Pont De Nemours & Co., Inc. (page 153) or Polyethylene manufactured by Acadia Synthetic Products Division of Western Felt Works (page 151) for representative properties.



T=24°C



Chemical Name: Polyethylene. Sample Designation: Sample No. A-3305

Composition: Linear addition polymer of polyethylene (100%).

Properties: White translucent.  $d^{25}_4=0.94$ . Ten. Str. 1500. Rockwell 18R.

Imp.(Izod): 25°C 2.6. Flex. Str. 25°C 1655. Elong. 400%. Mach.: good. Spec. Heat 0.5.

Therm. Exp. 19.0. Therm. Cond.  $10.28 \times 10^{-4}$ . Def. Load 52%. Thermoplastic.

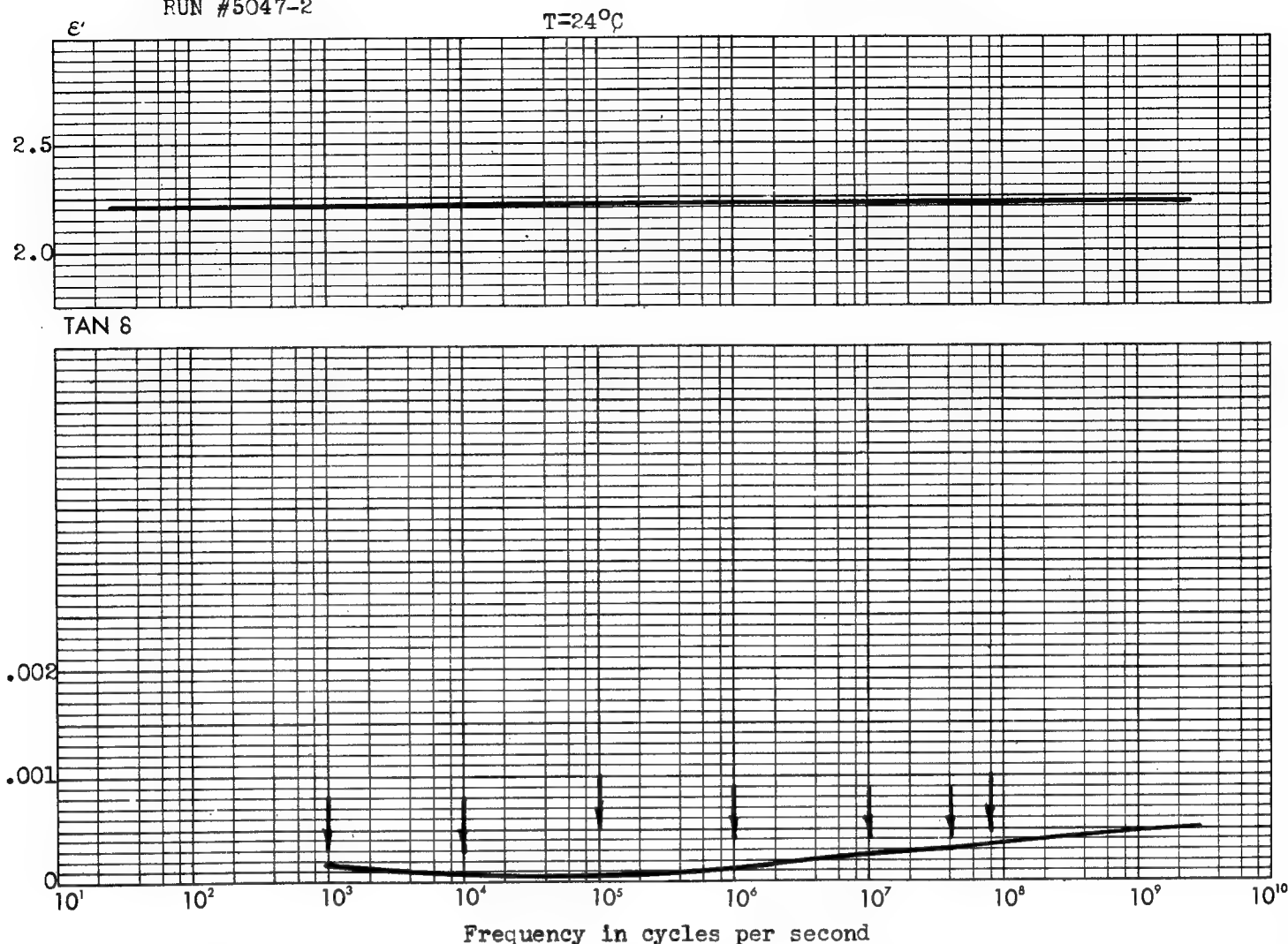
Chem. Res.: acids, excellent; alkalies, excellent; oxygenated solvents, excellent; chlorinated solvents, poor; water, excellent; oxygen, excellent. Sun.: slight.

Moist. Abs. 0.025%. Flam.: ignites and burns slowly. Elec. Str. 300.  $n_D=1.52$ .

Methods of Handling: Cast.: solvent 10-15% Xylene solu., films may be deposited from hot solutions. Compr. Mold. 149-204°C, 2000-3000. Inj. Mold. 325-500°C, 10,000-25,000 dep. on type of machine & die. Extr. 116-154°C. Calender rolling, block process sheets.

Recommended Uses: Containers, tubes, electrical insulation, high frequency cable insulation.

Availability: Granular molding powder and finished material in sheets, rods or tubes which can be machined. Produced on a commercial basis and under allocation.



Chemical Name: Polyisobutylene. Sample Designation: No.5047-2 (Esso Labs.)

Composition: Linear addition polymer of 100% isobutylene.

Properties: Clear water-white to light amber rubber-like solid.  $d_{25}^{25}=0.91$ .  
Av. mol. wt. (Staudinger)  $100,000 \pm 10,000$ . Elong.  $>1,100\%$  on Scott Tester.  
 $T_{dis}=25^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids  $80^{\circ}\text{C}$ , resistant to all except conc. nitric; alkalis, excellent; solvents, soluble in aromatic and aliphatic hydrocarbons and chlorinated hydrocarbons whose  $\zeta' < 8$  & in high mol. wt. mono alcohols, esters and ketones - insoluble in low mol. wt. oxygenated materials as alcohols, ethers, esters, ketones & in chlorinated hydrocarbons whose  $\zeta' > 8$  and in fatty oils; water, excellent; oxygen, excellent  $<100^{\circ}\text{C}$ . Sun.: depolymerized by sunlight. Moist. Abs.: low. Elec. Str. 600 (10-mil sheet). Arc Res.: good.

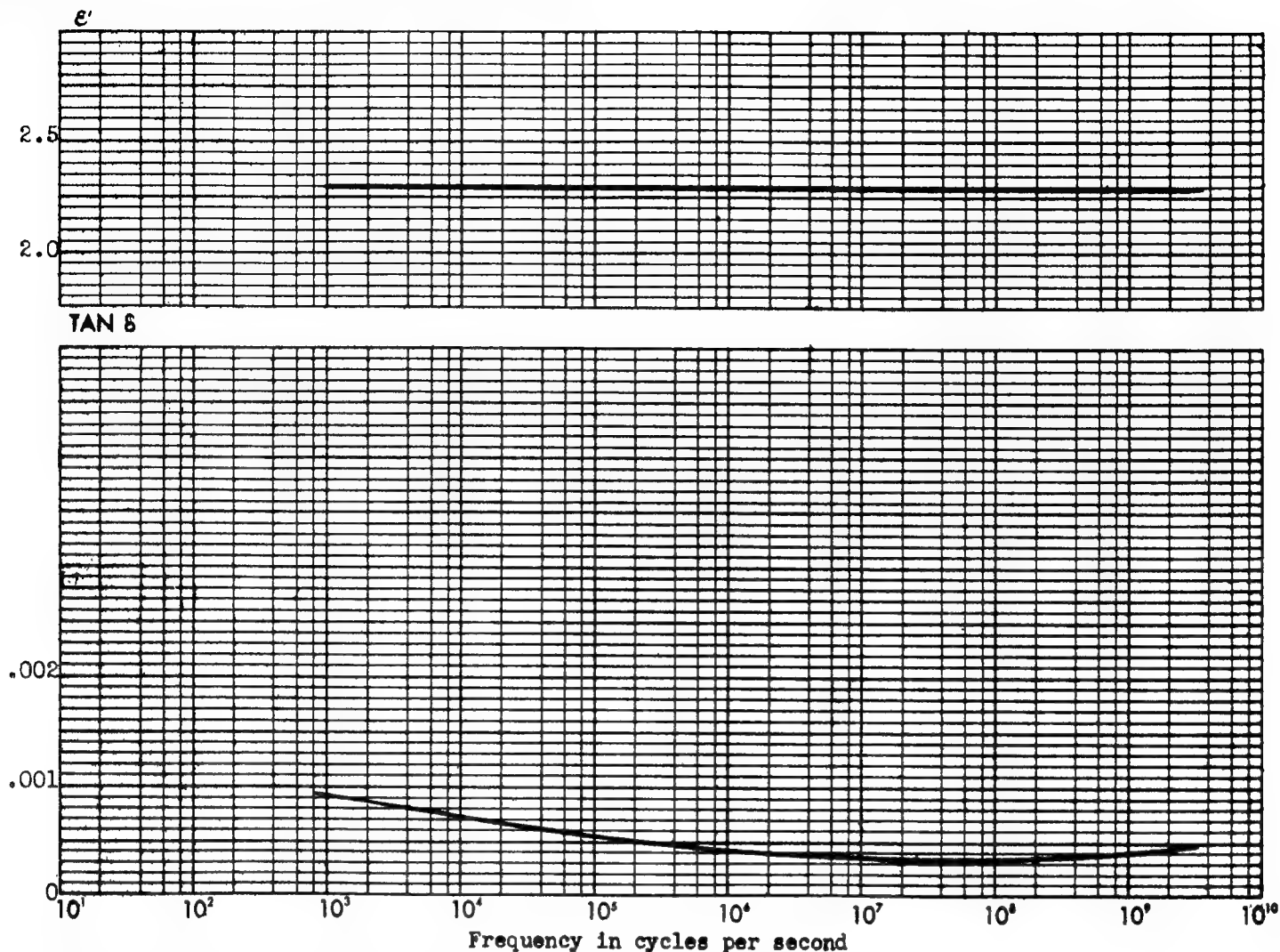
Methods of Handling: Compr. Mold.  $140^{\circ}\text{C}$ , 1000. Extr.  $149^{\circ}\text{C}$ .

Recommended Uses: Compounding ingredient in electrical insulation, ozone-resisting tape, general rubber compounds, adhesives, and adhesive tapes.

Availability: Available in production quantity under allocation.

**NOTE:** Distributed as Vistanex (Medium) by Advance Solvents and Chemical Co. and as Synthetic 100 by Moore and Munger.





Chemical Name: Polystyrene-polyisobutylene compound.

Sample Designation: Research Sample No. D-955.

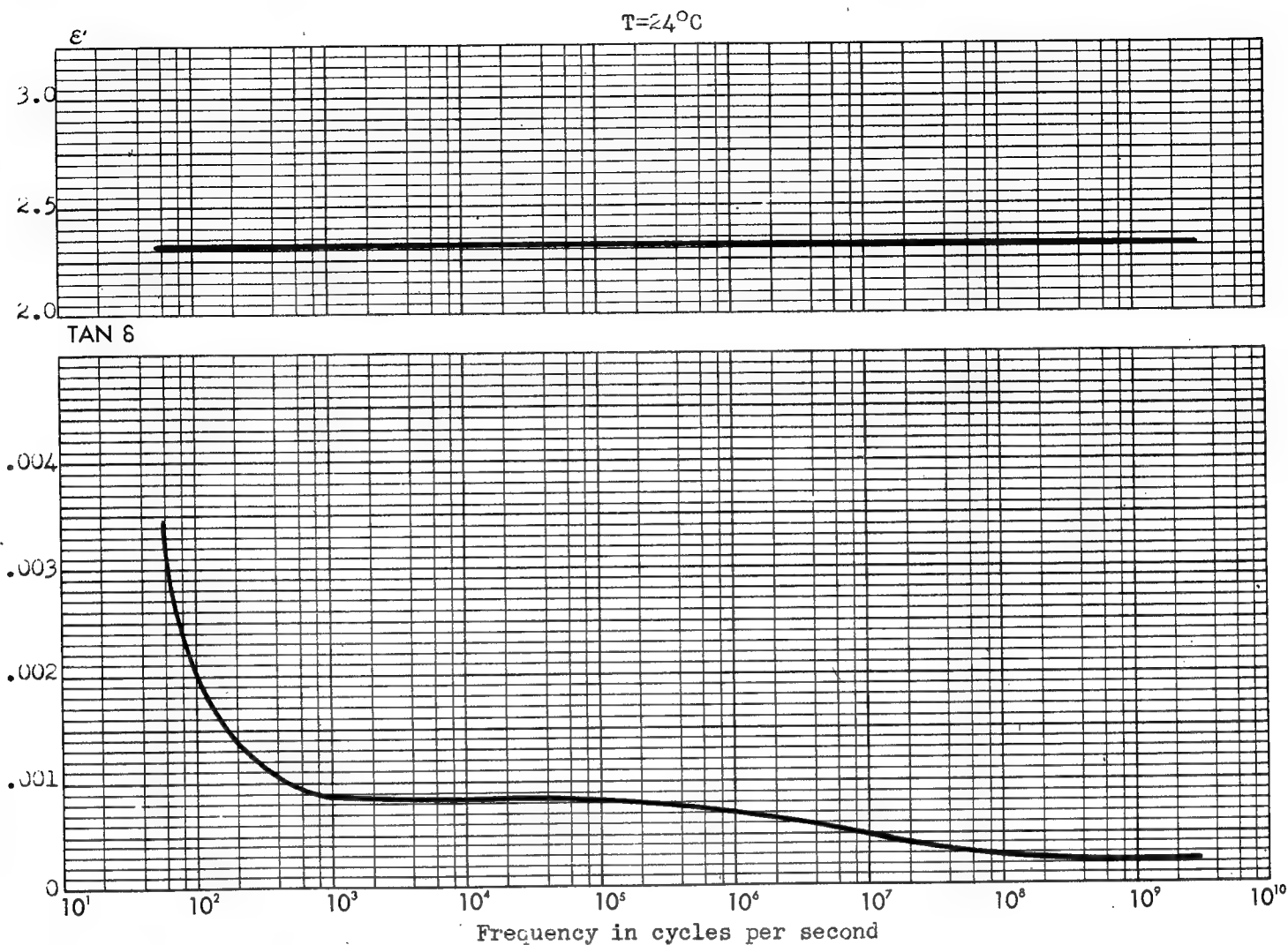
Composition: Mixture of linear addition polymers. Polystyrene (53%), polyisobutylene (67%).

Properties: White opaque.  $d^{25}_4 = 0.960$ .

Methods of Handling: Compression molding, injection molding and extrusion possible.

Recommended Uses: Electrical insulation.

Availability: Pilot plant quantities.



Chemical Name: Polystyrene-polyisobutylene compound.

Sample Designation: Research Sample No. D-957

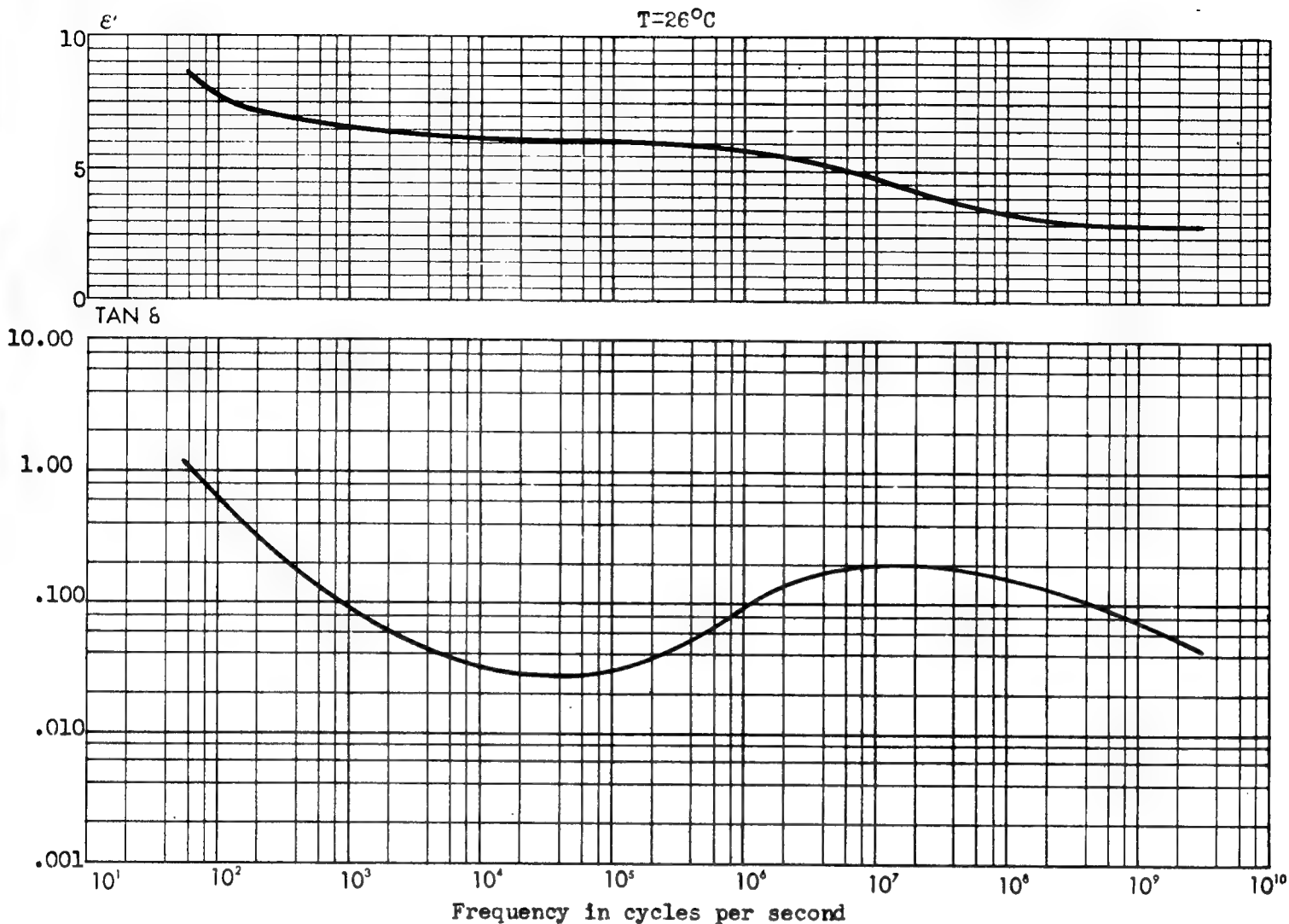
Composition: Mixture of linear addition polymers plasticized. Polystyrene (31.7%), polyisobutylene (63.5%) and Aroclor (4.8%).

Properties: White opaque.  $d^{25}_4=0.986$ .

Methods of Handling: Compression molding, injection molding and extrusion possible.

Recommended Uses: Electrical insulation.

Availability: Pilot plant quantities.



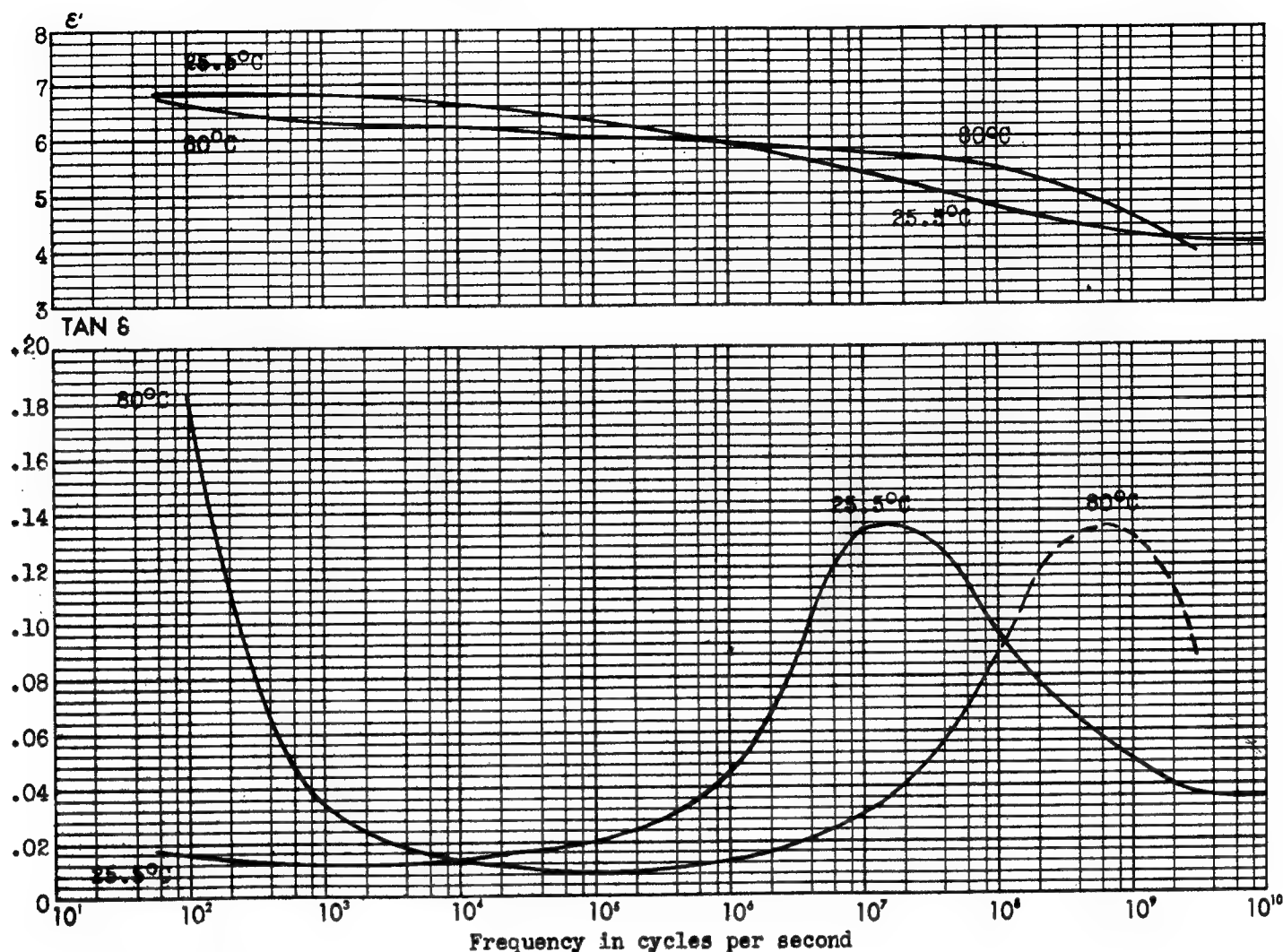
Chemical Name: Polymerized 2-chloro butadiene 1-3

Composition: Linear addition polymer of 2-chloro, butadiene 1-3 stabilized with a small amount of tetra methyl thiuram disulfide.

Properties: Amber colored rods.  $d^{25}=1.25$ . Spec. Heat 0.52.

Methods of Handling: On normal rubber processing equipment. Compounded with conventional type of fillers. All types of molds suitable and pressure is not critical. Compounded stock can be extruded or molded. Curing range  $108^{\circ}\text{C}$ - $163^{\circ}\text{C}$ .

Availability: Amber colored rods in production quantities under allocation.

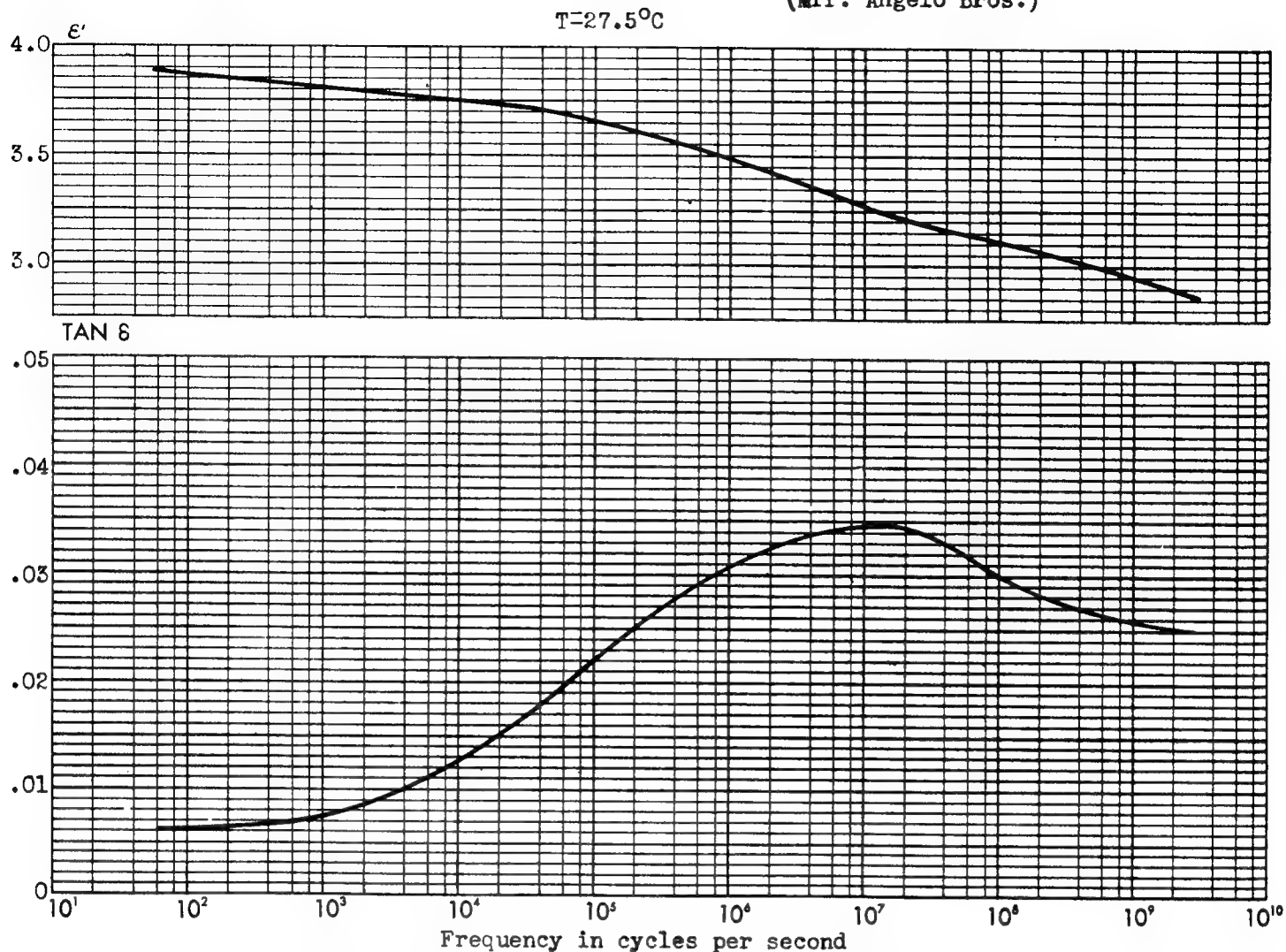


Sample Designation: 1282N-171

Composition: Linear addition polymer - 38% neoprene; Filler 19.0% Blanc Fixe ( $\text{BaSO}_4$ ), 0.4% Gastex (Carbon Black), 28.4% Catalpo Clay; Plasticizer 1.9% Paraffin, 3.8% Circo Light Process Oil, 0.2% Stearic Acid; Miscellaneous 0.8% Neozone A, 0.4% Parazone, 7.6% Litharge.

Properties: Dark grey.  $d_{25}^{25}=1.85$ . Ten. Str. 1200. Shore (Type A) 60. Mod. El. 700 at 500%. Elong. 755%. Therm. Sta.: good. Chem. Res.: acids, good; alkalies, good; aromatic solvents, fair; aliphatic solvents, good; water, good; oxygen, excellent. Sun.: discolors, no loss of physical properties and no cracking. Moist. Abs.: nil. Flam.: does not propagate a flame. Elec. Str. 300.

Recommended Uses: Mechanical goods; hose, tubing, belting, packing, gaskets, sponges, thread, wire, inner tubes, industrial tires, coated fabrics, drug sundries, jar rings, tank linings, heels and soles, boots and shoes, oil well supplies, printing rolls, etc.

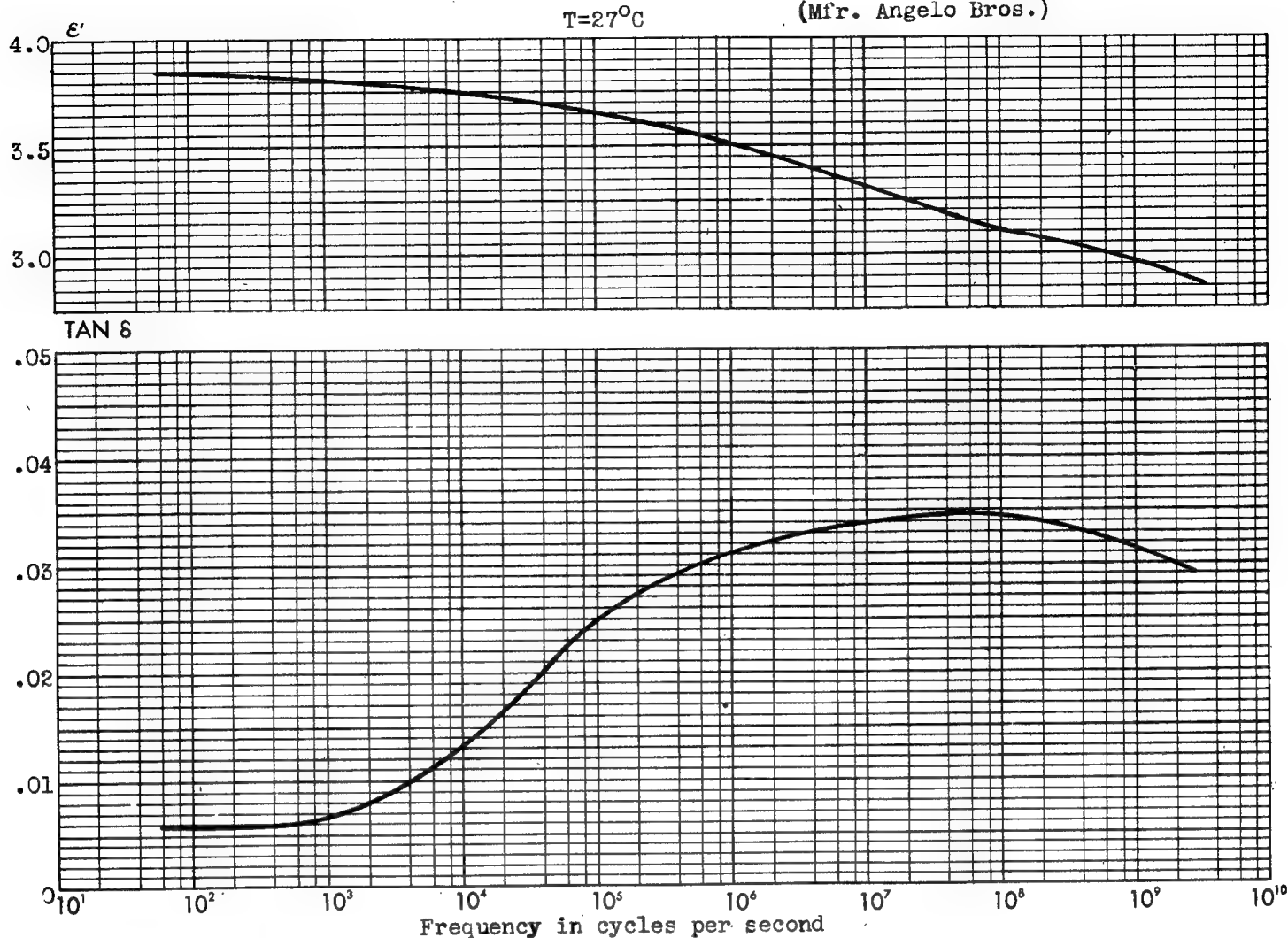


Composition: Natural shellac. Contains natural shellac wax (ca. 3.5%).

Properties: Light orange flakes.  $d^{25}=1.2$ .  $T_{\text{soft}}$ : ca.  $80^{\circ}\text{C}$ . Thermoplastic. Thermosetting on baking. Chem. Res.: dilute acids, good; alkalies, poor unless baked; solvents, hydrocarbons good; water, after baking good; oxygen, good. Sun.: none. Moist. Abs.: at  $27^{\circ}\text{C}$ , 1.5%, 50% humidity; 4.8%, 100% humidity; after baking low. Flam.: very slow.

Recommended Uses: A high grade shellac for general electrical and other uses. Extensively used in electrical work. Good color.

Availability: Freely available.



Composition: Natural shellac. Contains natural shellac wax (ca. 3.5%).

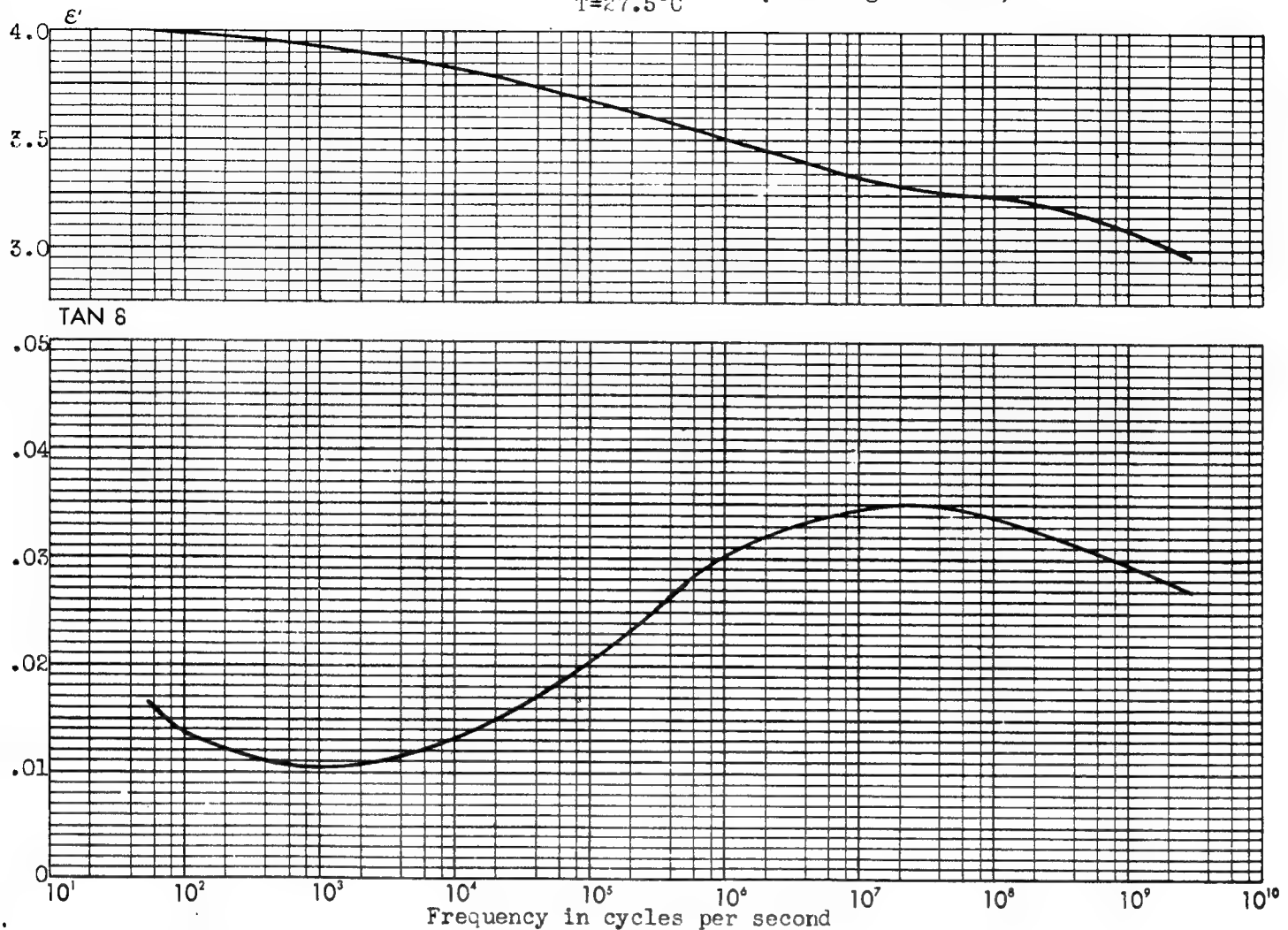
Properties: Dark orange in thin flakes.  $d^{25}=1.2$ .  $T_{\text{soft}}$ : ca.  $80^{\circ}\text{C}$ . Thermoplastic. Thermosetting on baking. Chem. Res.: dilute acids, good; alkalies, poor unless baked; solvents, hydrocarbons good; water, after baking good; oxygen, good. Sun.: none. Moist. Abs.: at  $27^{\circ}\text{C}$ , 1.5%, 50% humidity; 4.8%, 100% humidity; after baking low. Flam.: very slow.

Recommended Uses: Extensively used in electrical work and in other lines where a dark color is not objectionable.

Availability: Freely available.

(Mfr. Angelo Bros.)

T=27.5°C



Composition: Natural shellac. Contains natural shellac wax (ca. 2%).

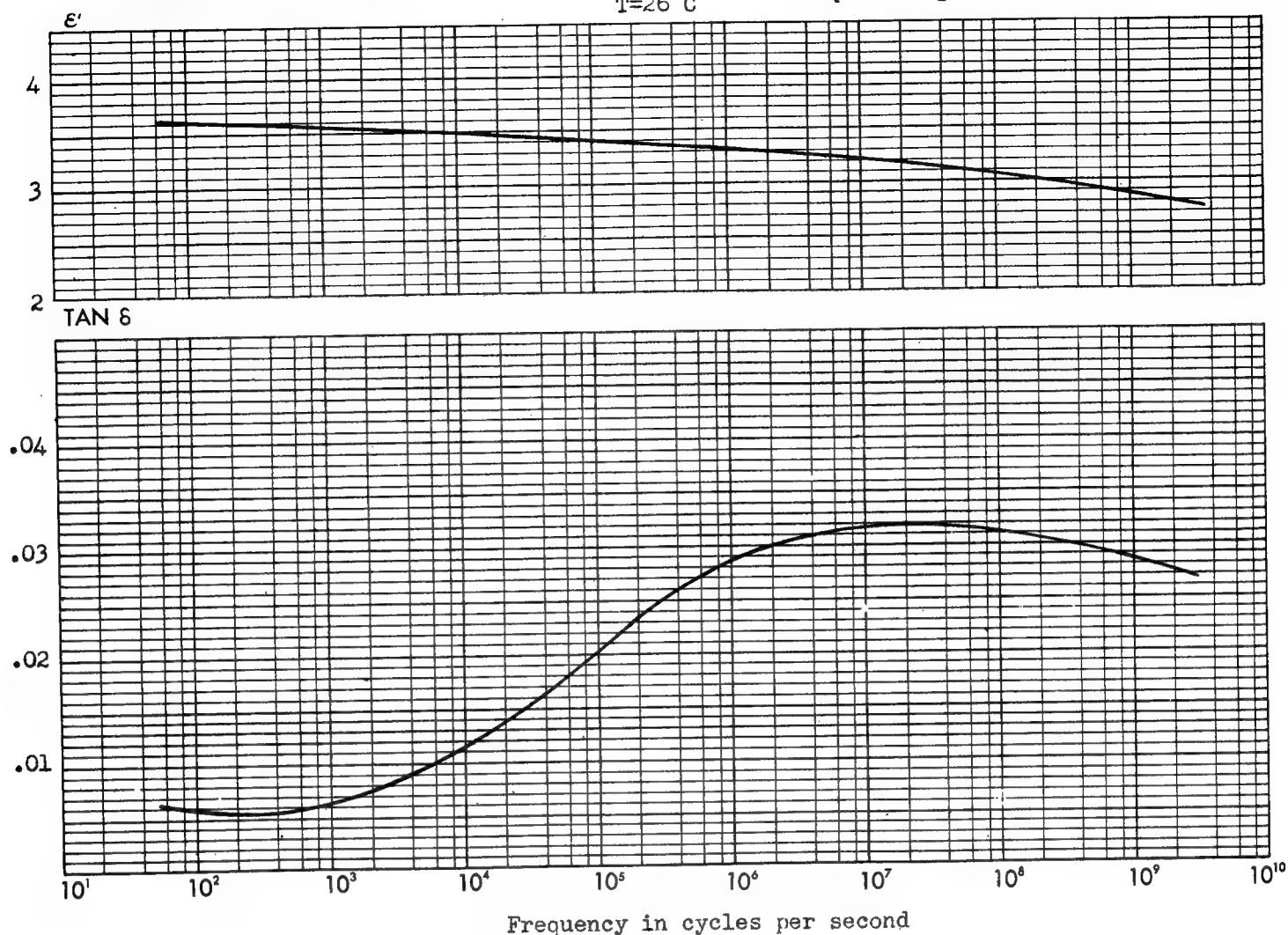
Properties: Dark garnet - thick flakes.  $d_{25}^{25}=1.2$ .  $T_{\text{soft}}$ : ca. 82°C. Thermoplastic. Thermosetting on baking. Chem. Res.: dilute acids, good; alkalis, poor unless baked; solvents, hydrocarbons good; water, after baking good; oxygen, good. Sun.: none. Moist. Abs. after baking low. Flam.: very slow.

Recommended Uses: Extensively used in electrical work and in other lines where a dark color is not objectionable.

Availability: Freely available.



T=26°C



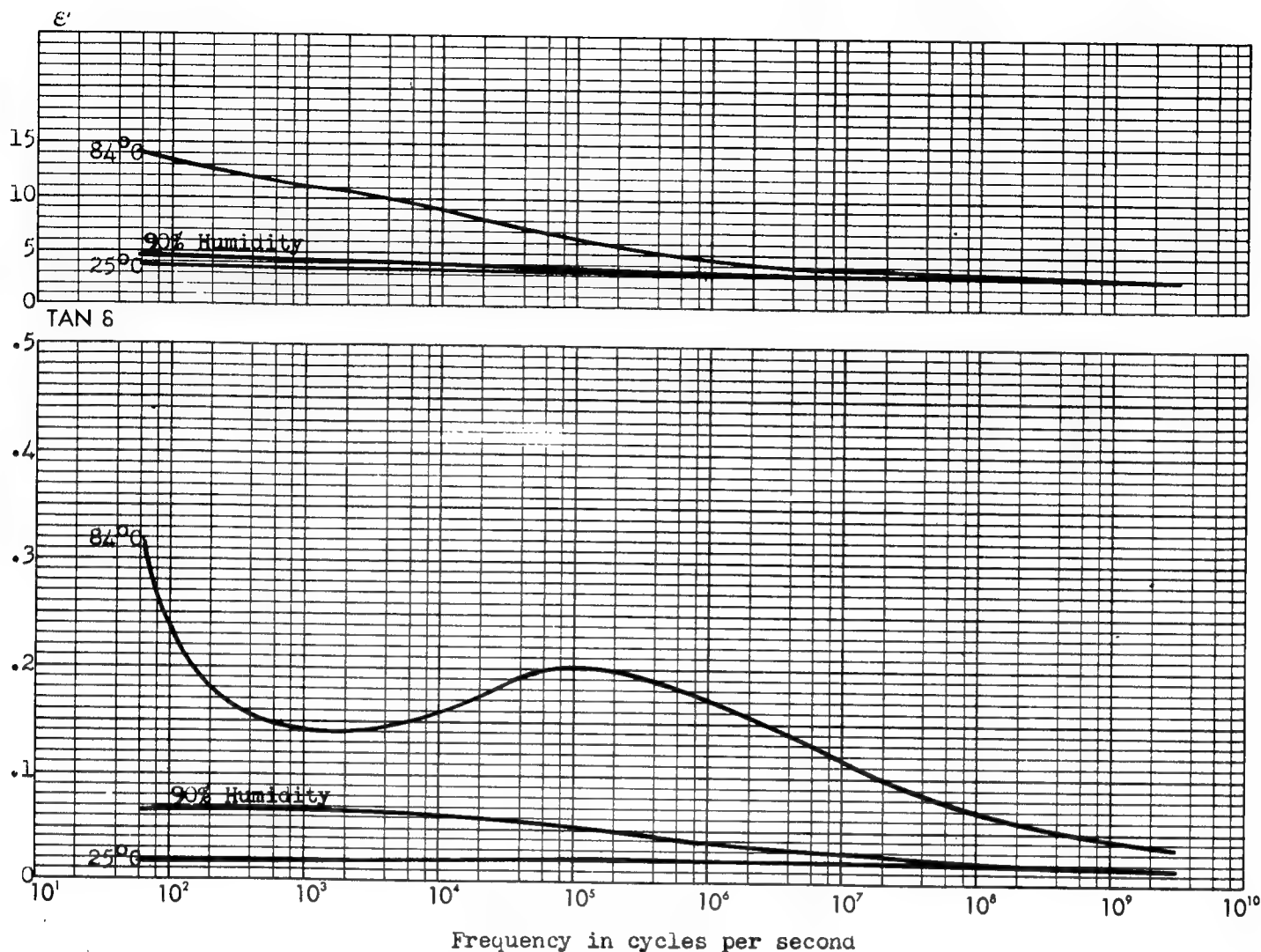
Composition: Natural shellac, wax free.

Properties: Dark garnet flakes.  $d_{25}^{25}=1.2$ .  $T_{\text{soft}}$ : ca. 75°C. Thermoplastic. Thermosetting on baking. Chem. Res.: dilute acids, good; alkalies, poor unless baked; solvents, petroleum and hydrocarbons good; water, after baking good; oxygen, good. Sun.: none. Moist. Abs.: after baking low. Flam.: very slow.

Recommended Uses: Special uses outside electrical field.

Availability: Limited.





Chemical Name: Polyhexamethylene-adipamide. Sample Designation: FM-1

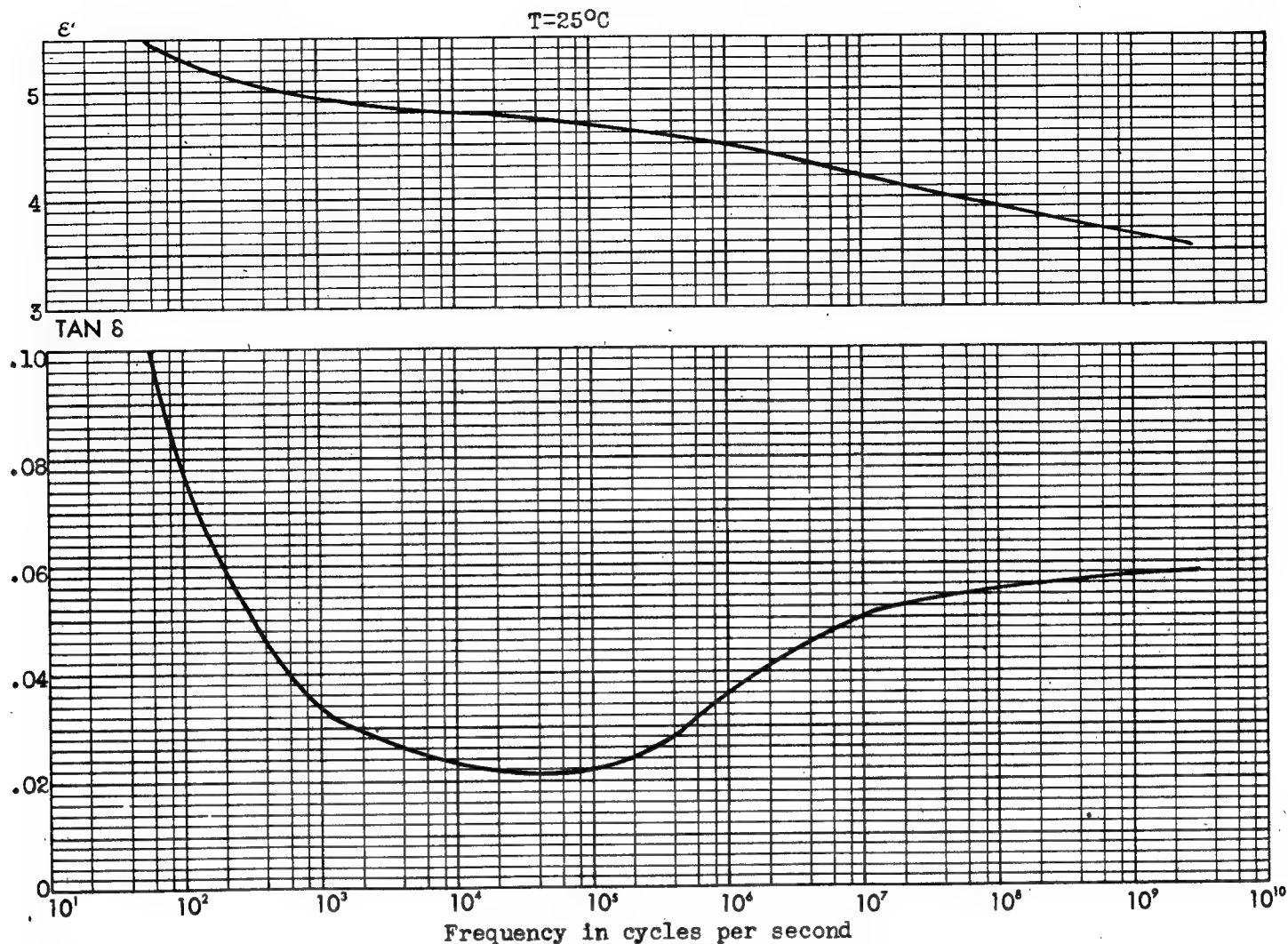
Composition: Linear condensation polymer made from hexamethylene diamine and adipic acid.

Properties: Light cream, translucent.  $d_{25}^{25}=1.14$ . Ten. Str. 9000-10,000. Rockwell L100, H65. Imp.(Izod):  $-57^{\circ}\text{C}$  0.42;  $25^{\circ}\text{C}$  0.94;  $77^{\circ}\text{C}$  0.87. Mod. El.  $3.3 \times 10^5$ . Flex. Str.:  $25^{\circ}\text{C}$  12,000-15,000. Elong. 50-80%. Mach.: excellent. Spec. Heat 0.55. Therm. Exp.  $10.3 \times 10^{-5}$ . Therm. Cond.  $6.0 \times 10^{-4}$ .  $T_{dis}$   $65^{\circ}\text{C}$ . Def. Load 4% at  $50^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: weak acids, good; alkalies, good; alcohols and common solvents, good; water, good. Sun.: slight discoloration. Moist. Abs. 1.5%. Flam.: self-extinguishing. Elec. Str.: 400 short time; 300 step-by-step.

Methods of Handling: Compr. Mold.  $128^{\circ}\text{C}$ , 1000. Inj. Mold.  $266-327^{\circ}\text{C}$ , 10,000-12,000.

Recommended Uses: Heat-resistant parts, coil forms, switches, wire insulation, rigid insulators.

Availability: Granular molding powder and finished material in monofilaments up to 0.060". Powders can be injection molded or extruded over wire. Available in either production or experimental quantities under allocation.



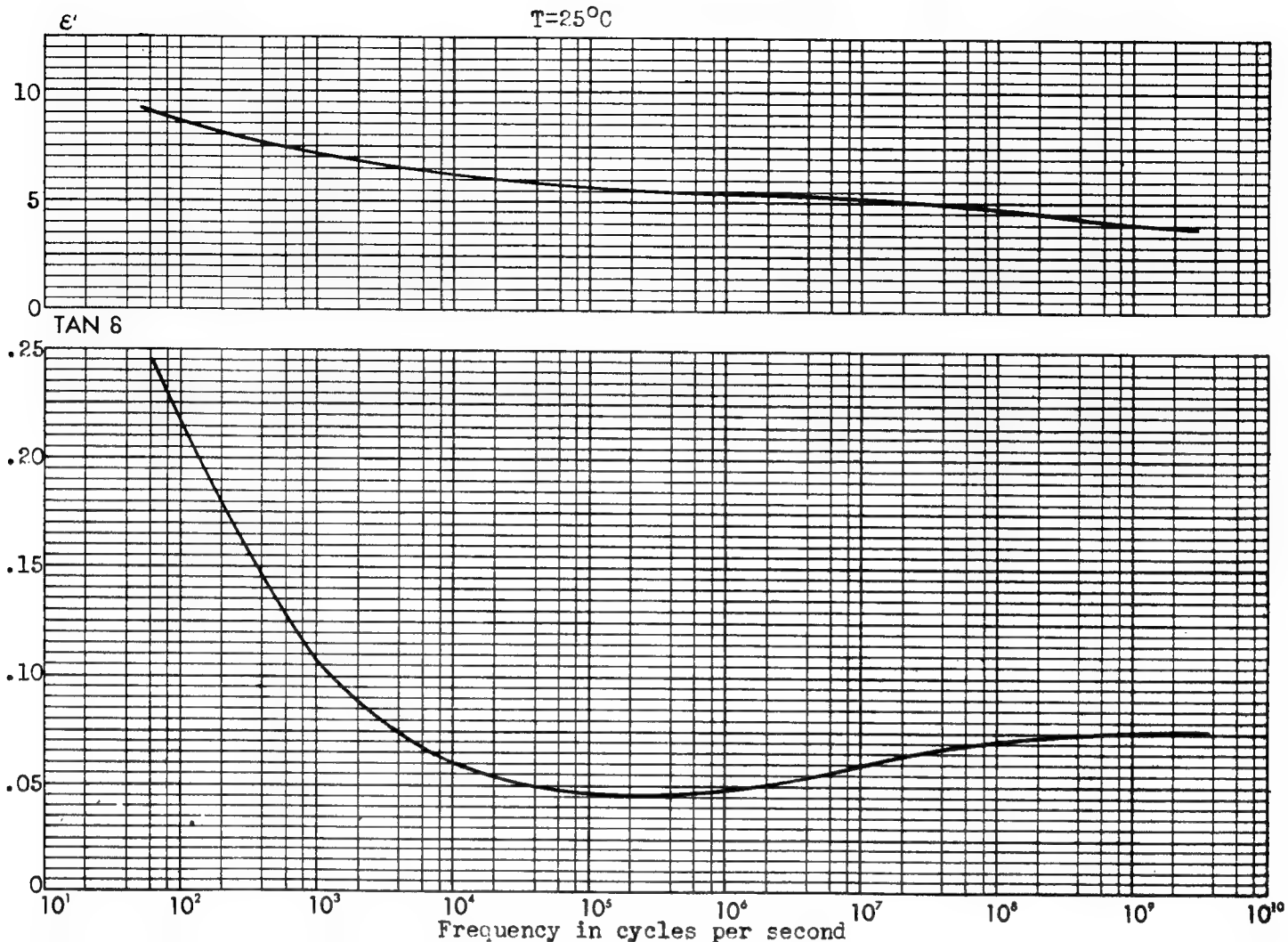
**Chemical Name:** Laminated cresylic acid formaldehyde resin.

**Composition:** Cross-linked condensation polymer of cresylic acid and formaldehyde - 50% cellulose paper.

**Properties:** Yellow.  $d_{25}^{25}=1.35$ . Ten. Str. 13,500 with grain; 10,500 cross-grain. Rockwell M111. Imp.(Charpy) 5.3 unnotched. Mod. El. 700,000. Comp. Str. 36,000. Shear. Str. 6000. Flex. Str. 15,000 with grain  $25^{\circ}\text{C}$ . Mach.: good. Spec. Heat 0.42. Therm. Exp.  $3 \times 10^{-5}$ . Therm. Cond.: about  $4.72 \times 10^{-4}$ .  $T_{dis} > 125^{\circ}\text{C}$ .  $T_{soft} > 125^{\circ}\text{C}$ . Therm. Sta.  $125^{\circ}\text{C}$ . Thermosetting. Chem. Res.: acids, fair; alkalies, fair; solvents, good; water, good; oxygen, good. Sun.: darkens. Moist. Abs. 1.2%. Flam.: very slow.

**Recommended Uses:** Panelboards, terminal strips, etc.

**Availability:** Commercial product in sheet form.



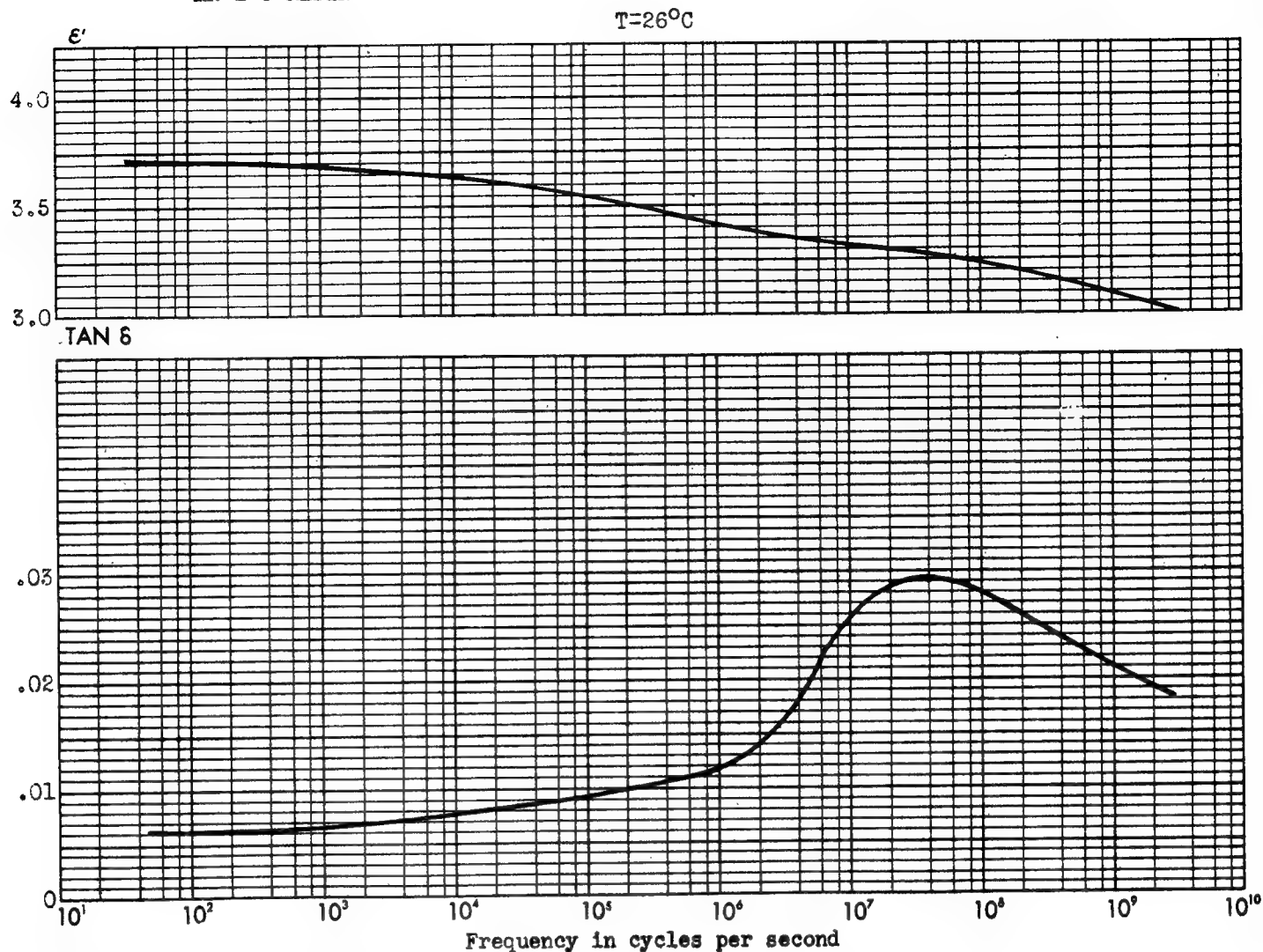
Chemical Name: Laminated cresylic acid formaldehyde resin.

Composition: Cross-linked condensation polymer of cresylic acid and formaldehyde - 50% cotton drilling, black dye used.

Properties: Black.  $d^{25}=1.35$ . Ten. Str.: 13,000 with grain; 12,000 cross-grain. Rockwell M108. Imp.(Charpy) 15.2 unnotched. Mod. El. 1,000,000. Comp. Str. 40,000. Shear. Str. 10,000. Flex. Str. 21,000 with grain  $25^\circ\text{C}$ . Mach.: good. Spec. Heat 0.42. Therm. Exp.  $3 \times 10^{-5}$ . Therm. Cond.: about  $4.72 \times 10^{-4}$ .  $T_{dis} > 125^\circ\text{C}$ .  $T_{soft} > 125^\circ\text{C}$ . Therm. Sta.  $125^\circ\text{C}$ . Thermosetting. Chem. Res.: acids, fair; alkalies, fair; solvents, good; water, good; oxygen, good. Sun.: darkens. Moist. Abs. 1.8%. Flam.: very slow.

Recommended Uses: Panelboards, terminal strips, etc.

Availability: Commercial product in sheet form.



Chemical Name: Allyl-type resin. Sample Designation: CG-548

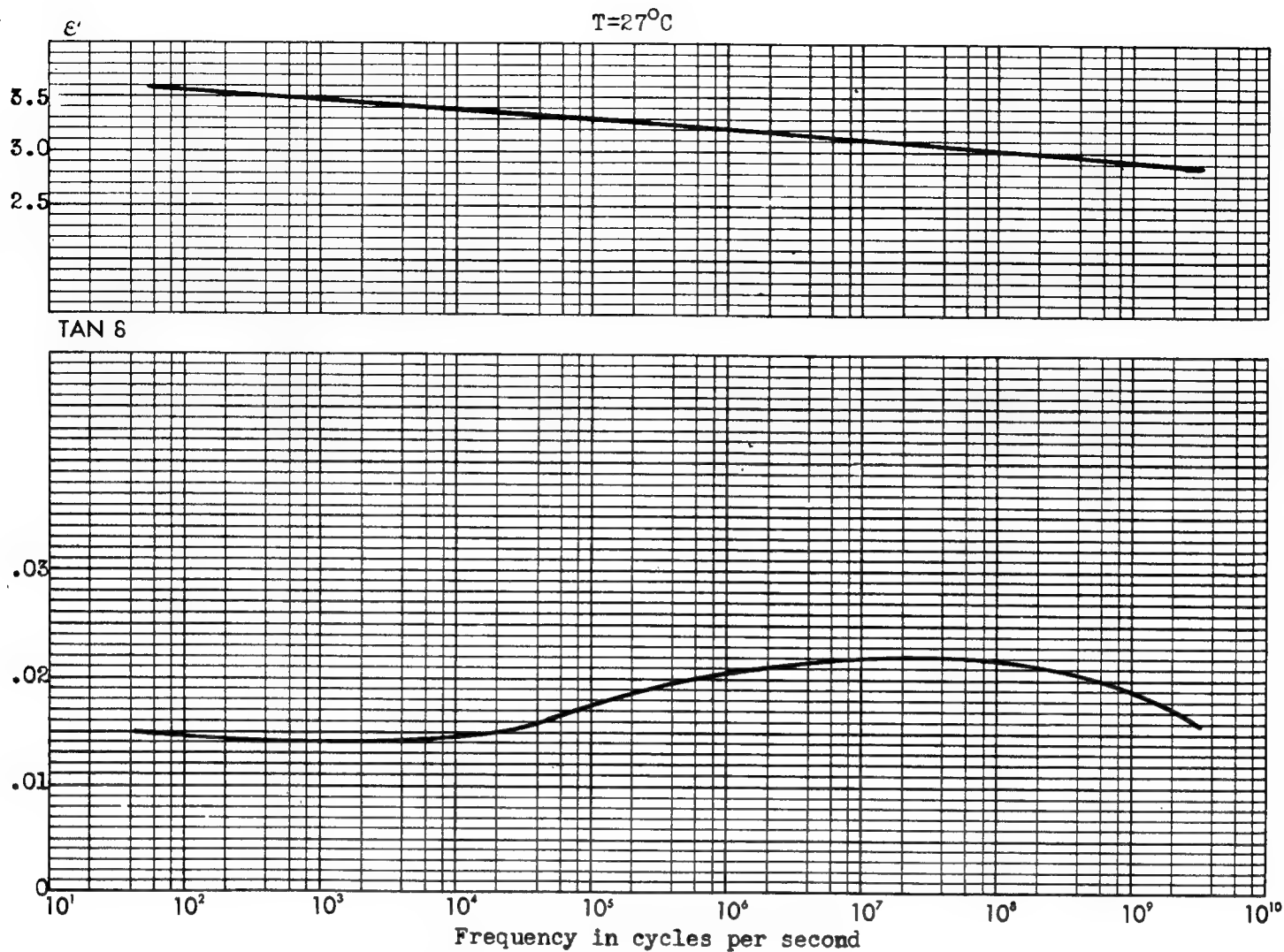
Composition: Cross-linked addition polymer (100%).

Properties: Transparent, yellow cast.  $d_{25}^{25}=1.243$ . Thermosetting

Methods of Handling: Cast. 75-115 C, 8 hrs. for 1/8" thick material.

Recommended Uses: Primarily a laminating resin.

Availability: Laminates in production quantities.



Sample Designation: JM-1343 & JM-1357

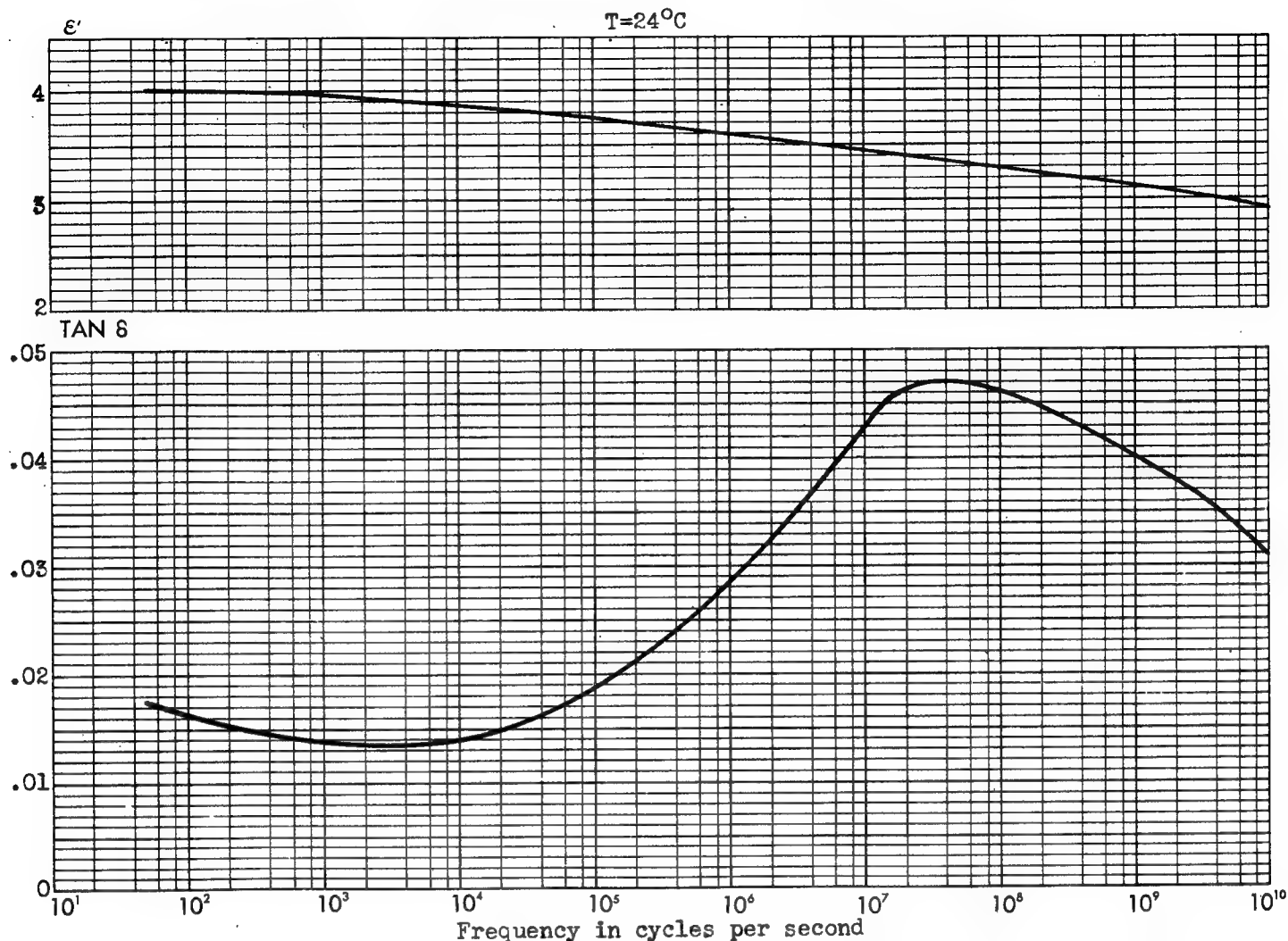
Composition: Cross-linked addition polymer (100%).

Properties: Transparent, slight yellowish color.  $d^{25}=1.208$ . Thermosetting.

Methods of Handling: Cast.  $75-115^{\circ}\text{C}$ , time varies with thickness of casting; 2-6 hrs. for  $1/8"$  thick material.

Recommended Uses: Primarily a laminating resin.

Availability: Laminates in production quantities, sheets and rods in experimental quantities.



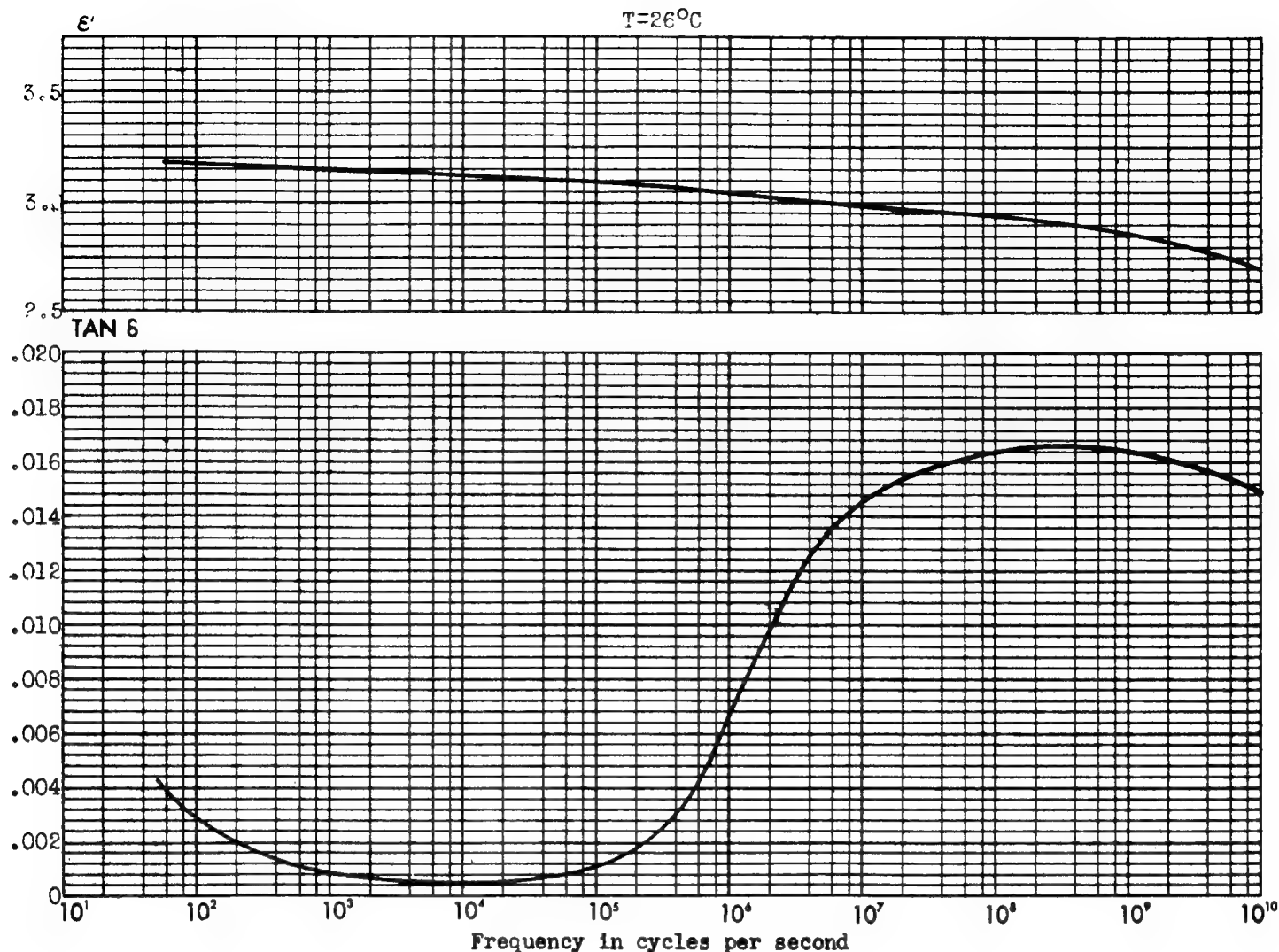
**Composition:** Cross-linked addition polymer with benzoyl peroxide (1%) as catalyst.

**Properties:** Clear, light amber.  $d_{25}^{25}=1.22$ .  $T_{ep}$  Str. 6500-6900. Rockwell M95. Imp. (Izod)  $25^{\circ}\text{C}$ , 0.20-0.25. Mod. El.  $0.4 \times 10^6$ . Comp. Str. 26,000. Flex. Str.:  $-40^{\circ}\text{C}$ , 15,000-15,300;  $25^{\circ}\text{C}$ , 12,500-13,900;  $80^{\circ}\text{C}$ , 6300-6600. Elong. 5-9%. Mach.: good, requires high speeds. Therm. Exp.  $60-130 \times 10^{-6}$ .  $T_{dis}$   $100^{\circ}\text{C}$ . M. P.  $330^{\circ}\text{C}$ . Therm. Sta.: good  $<100^{\circ}\text{C}$ , pliable at  $150^{\circ}\text{C}$ . Thermosetting. Chem. Res.: acids, good; alkalis, tends to craze and swell; solvents, good; water, good; oxygen, good. Sun.: very slight. Moist. Abs. 1%. Flam.: 1.08 in./min. Elec. Str. 500 short time test (1/8" thick). Arc Res. 90-126 sec.  $n_D=1.54$  at  $25^{\circ}\text{C}$ .

**Methods of Handling:** Cast.: thin sections 1/4" or less at  $65-105^{\circ}\text{C}$  for 1-4 hrs., average 2 hrs.

**Recommended Uses:** Generally used for contact and low pressure laminating of fibrous materials. Can be used in special applications such as casting around coils, etc.

**Availability:** Liquid in production quantities under allocation. Raw materials allocated but not critical.



Chemical Name: Ester of vinyl polybasic acid - polyhydric alcohol

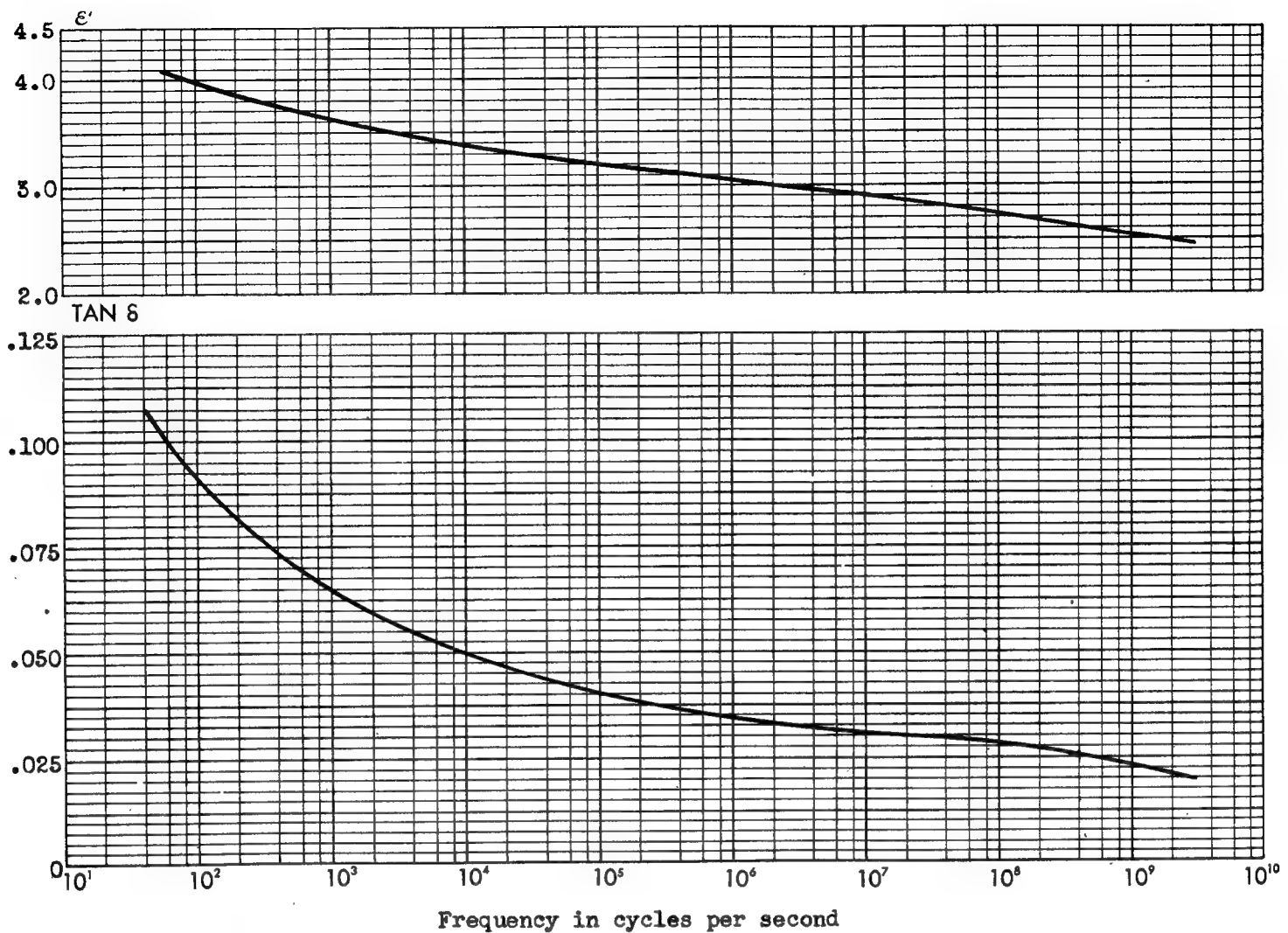
Composition: Cross-linked condensation resin.

Properties for a typical laminate with 55% by weight of cross-banded glass filler:  
 $d^{25}=1.60$ . Ten. Str. 47,000. Mod. El.: in tension  $2.04 \times 10^6$ ; in flexure  $2.69 \times 10^6$ .  
 Flex. Str. 51,000. Elong. 1.98%.  $T_{dis}$ : starts at  $60^{\circ}\text{C}$  and stops at  $170^{\circ}\text{C}$  and  
 3.2 mils when parallel to laminations; starts at  $60^{\circ}\text{C}$  and stops at  $140^{\circ}\text{C}$  and 5 mils  
 when perpendicular to laminations. Arc Res.: fair.

Method of Handling: Compression molding possible.

Availability: Experimental quantities.





Composition: Polymer, 95%; plasticizer, 5%.

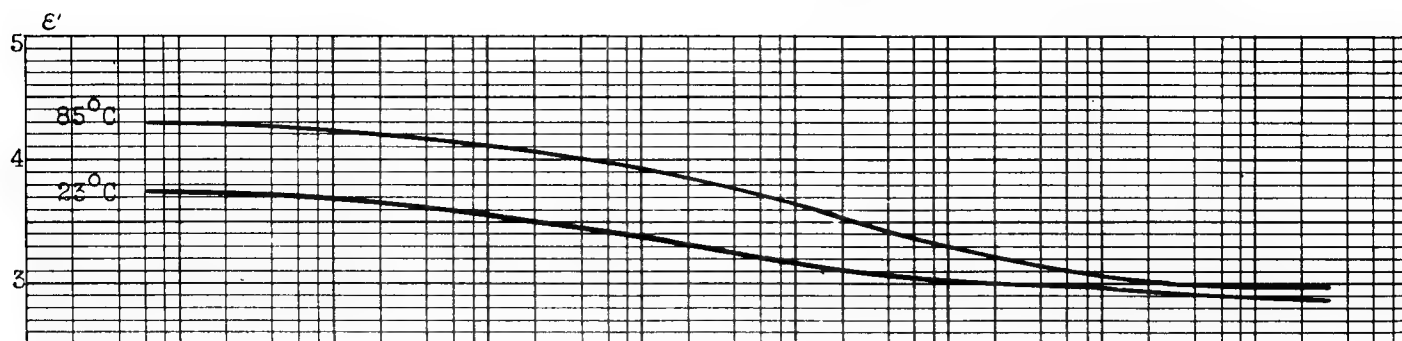
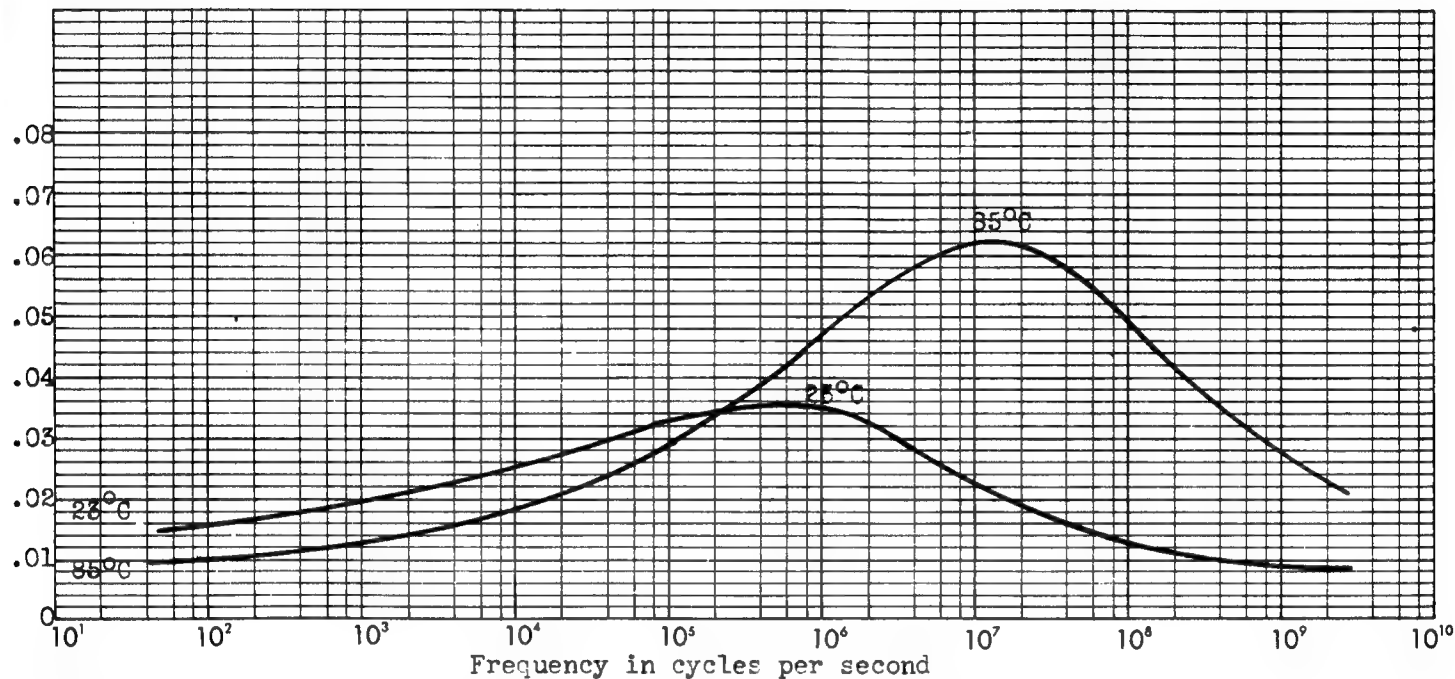
Properties: Opaque, light brown solid.  $d^{25}=1.03$ . Soft and slightly elastic at room temperature. M. P. 120-125°C.

Method of Handling: Impregnation at 150°C, 500 mm. vacuum.

Recommended Use: Coil impregnating material for use over a wide temperature range (-55°C to 115°C).

Availability: Developmental material.



TAN  $\delta$ 

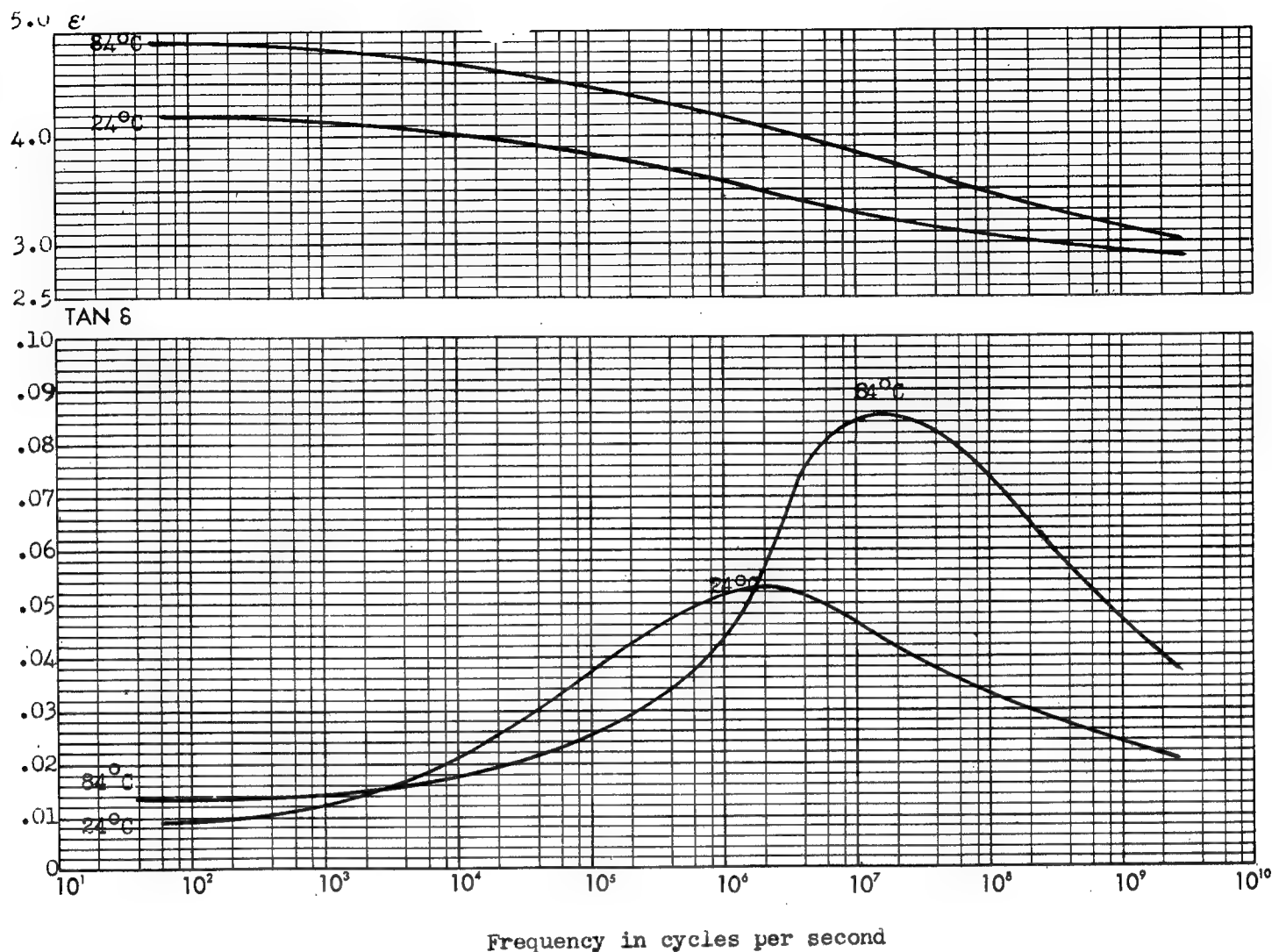
**Composition:** Cross-linked addition polymer (under secrecy order)

**Properties:** Colorless, transparent.  $d_{25}^{25}=1.31$ . Ten. Str. 5000-6000. Rockwell M95-100. Imp.(Izod):  $-40^{\circ}\text{C}$ , 0.30-0.40;  $25^{\circ}\text{C}$ , 0.25-0.35;  $80^{\circ}\text{C}$ , 0.20-0.30. Comp. Str. 20,000. Shear. Str. 5000. Flex. Str.:  $-40^{\circ}\text{C}$ , 14,000-15,000;  $25^{\circ}\text{C}$ , 8000-10,000;  $80^{\circ}\text{C}$ , 2900. Elong. 2%. Mach.: good. Spec. Heat 0.55. Therm. Exp.  $9 \times 10^{-5}$ . Therm. Cond.  $5 \times 10^{-4}$ .  $T_{dis}$  60-70°C. Therm. Sta.: good  $<125^{\circ}\text{C}$  (approx.), slight distortion without flow above heat distortion point. Thermosetting. Chem. Res.: acids, good; alkalies, good; solvents, excellent; water, excellent; oxygen, excellent. Sun.: slight. Moist. Abs. 0.2%. Flam.: 0.3-0.4 in./min. (Navy Test).  $n_D=1.50$ .

**Methods of Handling:** Cast.: at  $45-100^{\circ}\text{C}$  normally for several hours, depending on thickness.

**Recommended Uses:** Transparent windows in which excellent optical properties, solvent resistance and abrasion resistance are required; low pressure laminates; impregnation of porous materials.

**Availability:** Liquid in quantities up to approx. 20,000 lbs. per month - raw material under allocation.



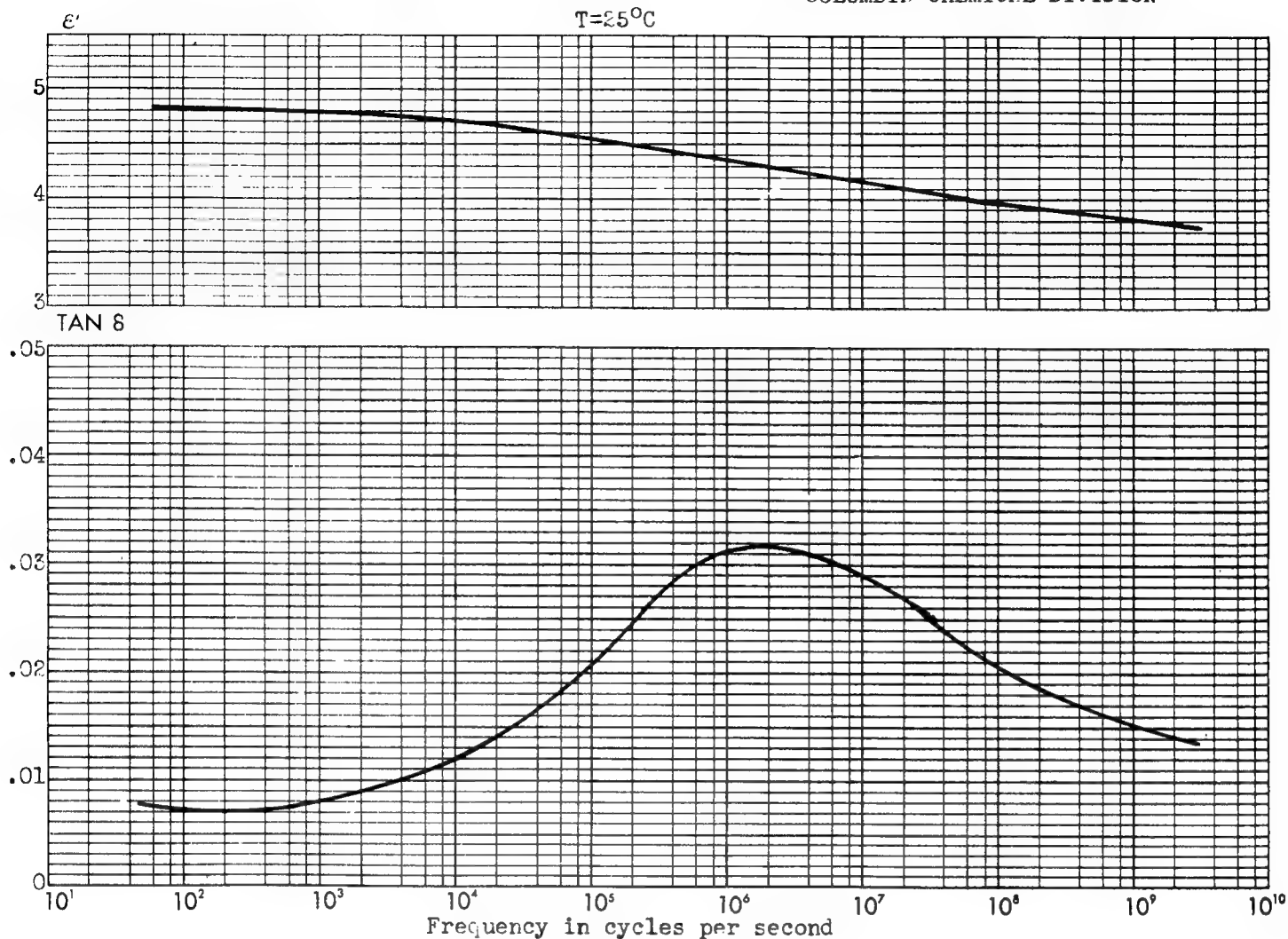
Composition: Cross-linked addition polymer (under secrecy order).

Properties: Colorless, transparent.  $d^{25}_D=1.31$ . Ten. Str. 5000-6000. Rockwell M95-100. Imp.(Izod):  $-40^\circ\text{C}$ , 0.30-0.40;  $25^\circ\text{C}$ , 0.25-0.35;  $80^\circ\text{C}$ , 0.20-0.30. Comp. Str. 20,000. Shear. Str. 5000. Flex. Str.:  $-40^\circ\text{C}$ , 14,000-15,000;  $25^\circ\text{C}$ , 8000-10,000;  $80^\circ\text{C}$ , 2900. Elong. 2%. Mach.: good. Spec. Heat 0.55. Therm. Exp.  $9 \times 10^{-5}$ . Therm. Cond.  $5 \times 10^{-4}$ .  $T_{dis}$  60-70°C.  $T_{soft}$ : none. Therm. Sta.: good  $<125^\circ\text{C}$  (approx.), slight distortion without flow above heat distortion point. Thermosetting. Chem. Res.: acids, good; alkalis, good; solvents, excellent; water, excellent; oxygen, excellent. Sun.: slight. Moist. Abs. 0.2%. Flam.: 0.30-0.40 in./min. (Navy Test).  $n_D=1.50$ .

Methods of Handling: Cast.: at  $45-100^\circ\text{C}$  normally for several hours depending on thickness.

Recommended Uses: Transparent windows in which excellent optical properties, solvent resistance and abrasion resistance are required; low pressure laminates; impregnation of porous materials.

Availability: Liquid in quantities up to approx. 20,000 lbs. per month - raw material under allocation.



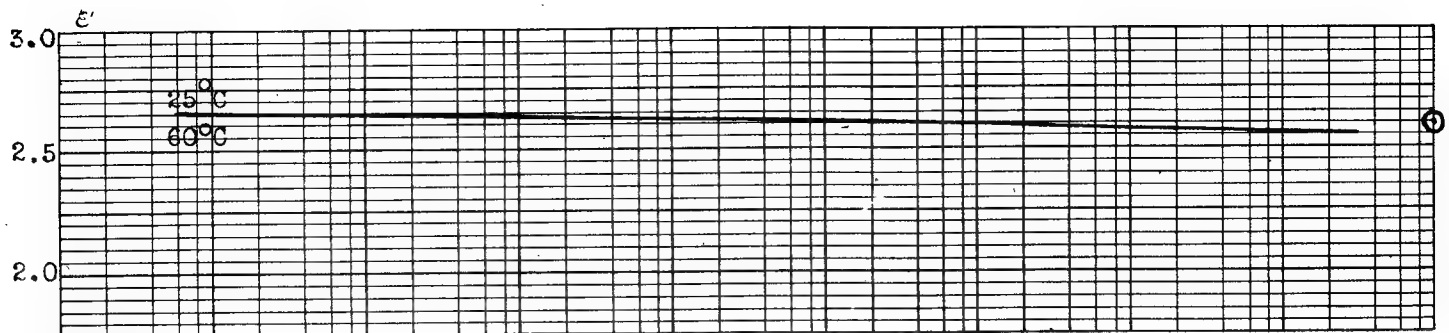
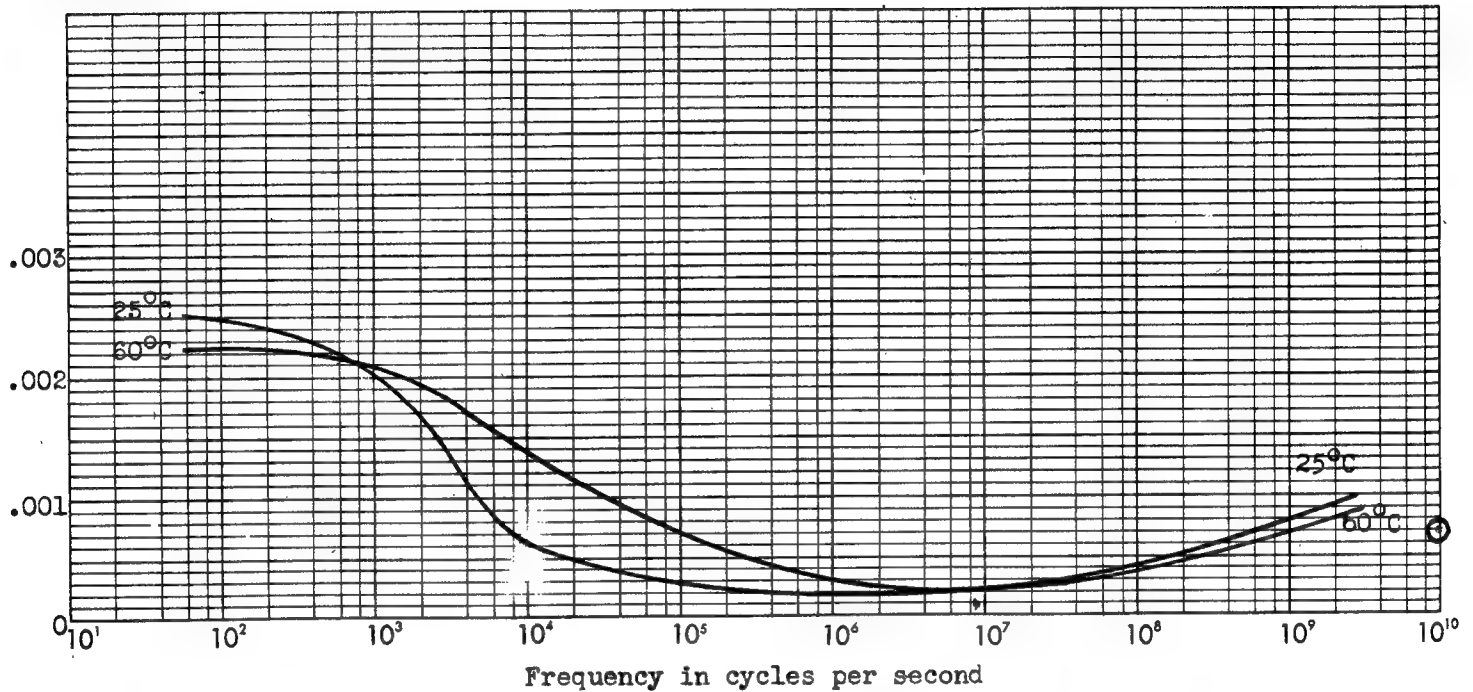
Sample Designation: Fiberglas ECC-11-148 laminate

Composition: Cross-linked addition polymer under secrecy order (40%) with crossed construction ECC-11-148 Fiberglas as filler (60%).

Properties: White, opaque.  $d^{25}=1.73$ . Ten. Str. 34,000-39,000. Rockwell M97. Imp. (Izod) 23. Mod. El.  $1.6 \times 10^6$  in flexure,  $25^{\circ}\text{C}$ . Comp. Str. 47,000-52,000 flatwise. Flex. Str.  $25^{\circ}\text{C}$ , 25,200. Mach.: fair: Therm. Exp.  $0-25^{\circ}\text{C}$ ,  $1.9 \times 10^{-5}$ . Therm. Sta.  $\leq 125^{\circ}\text{C}$ . Thermosetting. Chem. Res.: acids, good; alkalies, good; solvents, good; water, good; oxygen, good. Sun.: slight yellowing. Moist. Abs. 0.8%.

Recommended Uses: Electrical insulation, fabrication of structures.

Availability: CR-39 monomer available for manufacturers of laminates in production quantity up to approx. 20,000 lbs. per month under allocation.

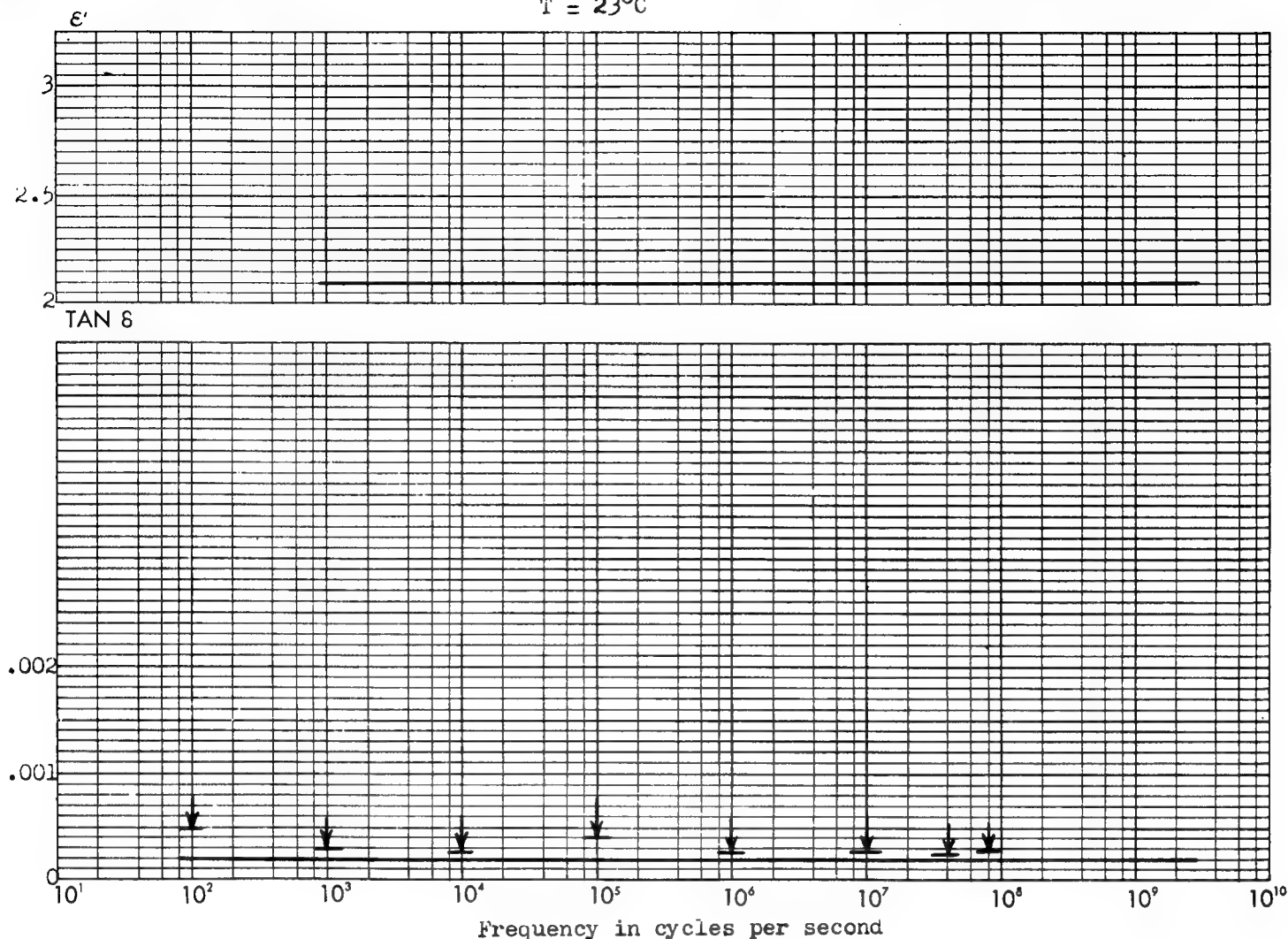
TAN  $\delta$ 

**Properties:** Gray.  $d^{25}=1.358$ . Ten. Str. 3240. Rockwell M72. Imp.(Izod): unnotched 5.7. Imp.(Charpy): notched 2.5. Mod. El.  $3.34 \times 10^5$ . Comp. Str. 11,400. Flex. Str. 6540. Mach.: good.  $T_{dis}$  84-86°C.  $T_{soft}$  138°C. Thermoplastic. Moist. Abs. 0.046%. Flam.: chars slightly but will not burn.

**Methods of Handling:** Compr. Mold. 135 C, 1000-10,000. Extrusion possible.

**Recommended Uses:** For rigid, high-frequency insulation, or for compounding into flexible cable coating.

**Availability:** In form of articles machined to specifications from extruded rods ranging in diameter from 3/16" to 3/4" and in sheet form.

$T = 23^{\circ}\text{C}$ 

Loss unchanged at  $3 \cdot 10^9$  cycles at  $80^{\circ}\text{C}$

Chemical Name: Under secrecy order. *Teflon*

Composition: Linear addition polymer under secrecy order.

Properties: Light gray & white translucent.  $d^{25} = 2.0-2.3$ . Ten. Str. 2000-4000.

Shore 55-75. Imp.(Izod):  $-57^{\circ}\text{C}$  2.0;  $25^{\circ}\text{C}$  4.3;  $77^{\circ}\text{C}$  6.3. Flex. Str.  $25^{\circ}\text{C}$  1600.

Elong. 300-400%. Therm. Exp.  $9.0 \times 10^{-5}$ . Therm. Cond.  $4.82 \times 10^{-4}$ .  $T_{\text{dis}}$   $66^{\circ}\text{C}$ .

Therm. Sta.: form stable to  $300^{\circ}\text{C}$ , distortion 8% at  $50^{\circ}\text{C}$  and 1200 psi. Thermoplastic.

Chem. Res.: acids, excellent; alkalies, excellent; solvents, excellent; water, excellent;

oxygen, excellent. Sun.: none. Moist. Abs. 0.00%. Flam.: not flammable. Elec. Str.

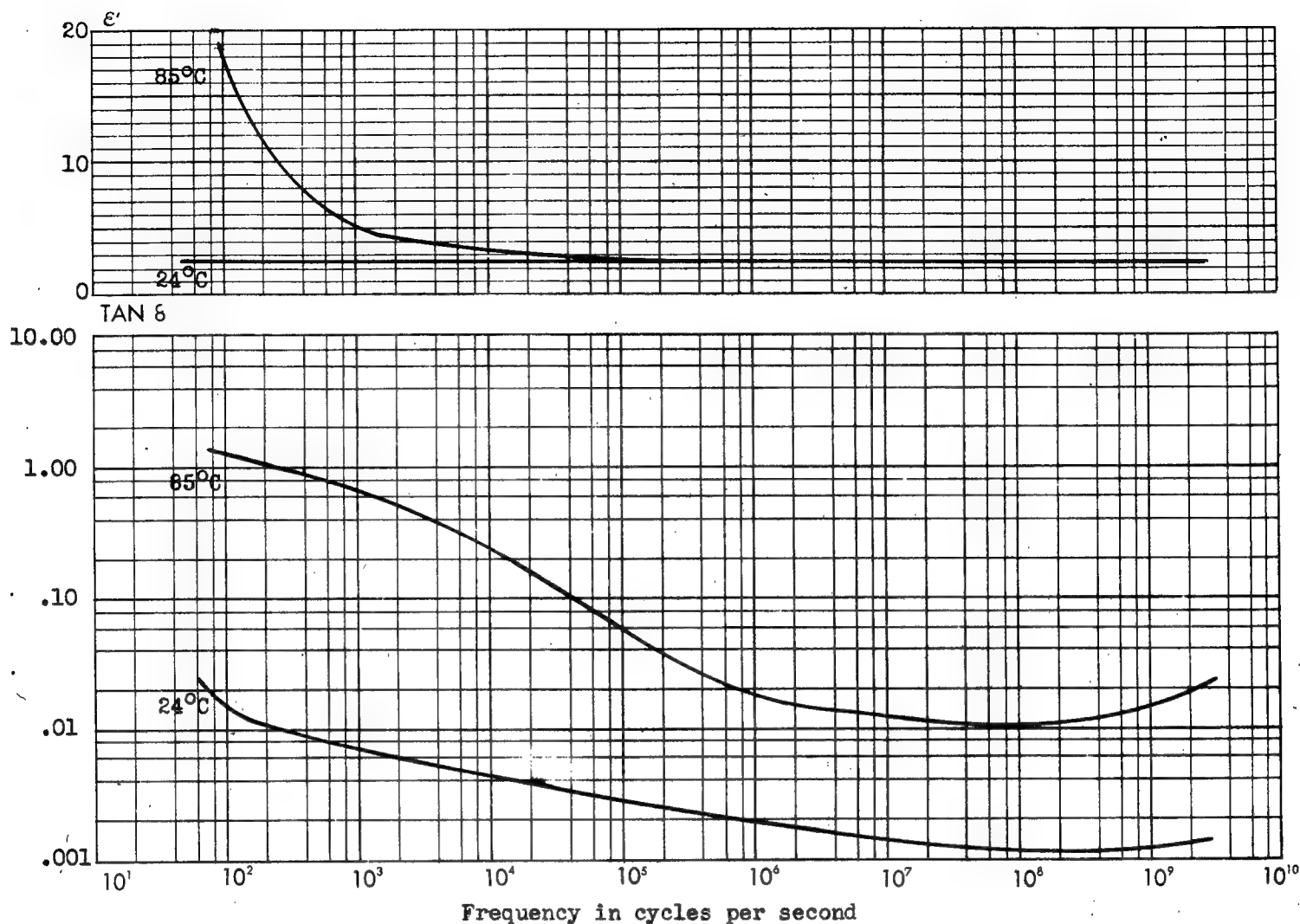
250-1600 for 0.012" thick - depends on thickness and manufacturing conditions.

$n_D = 1.35 \pm 0.05$ .

Methods of Handling: Material may be readily machined.

Recommended Uses: Electrical insulation over wide temperature ranges and/or in the presence of solvents and corrosive agents.

Availability: Molding powder and molded forms: sheets 14" x 14", 0.01" to 1.0" thick; strips 4" wide, in lengths to 100 feet, 0.003" to 0.025" thick; tape up to 1.5" wide, 0.002" to 0.025" thick.



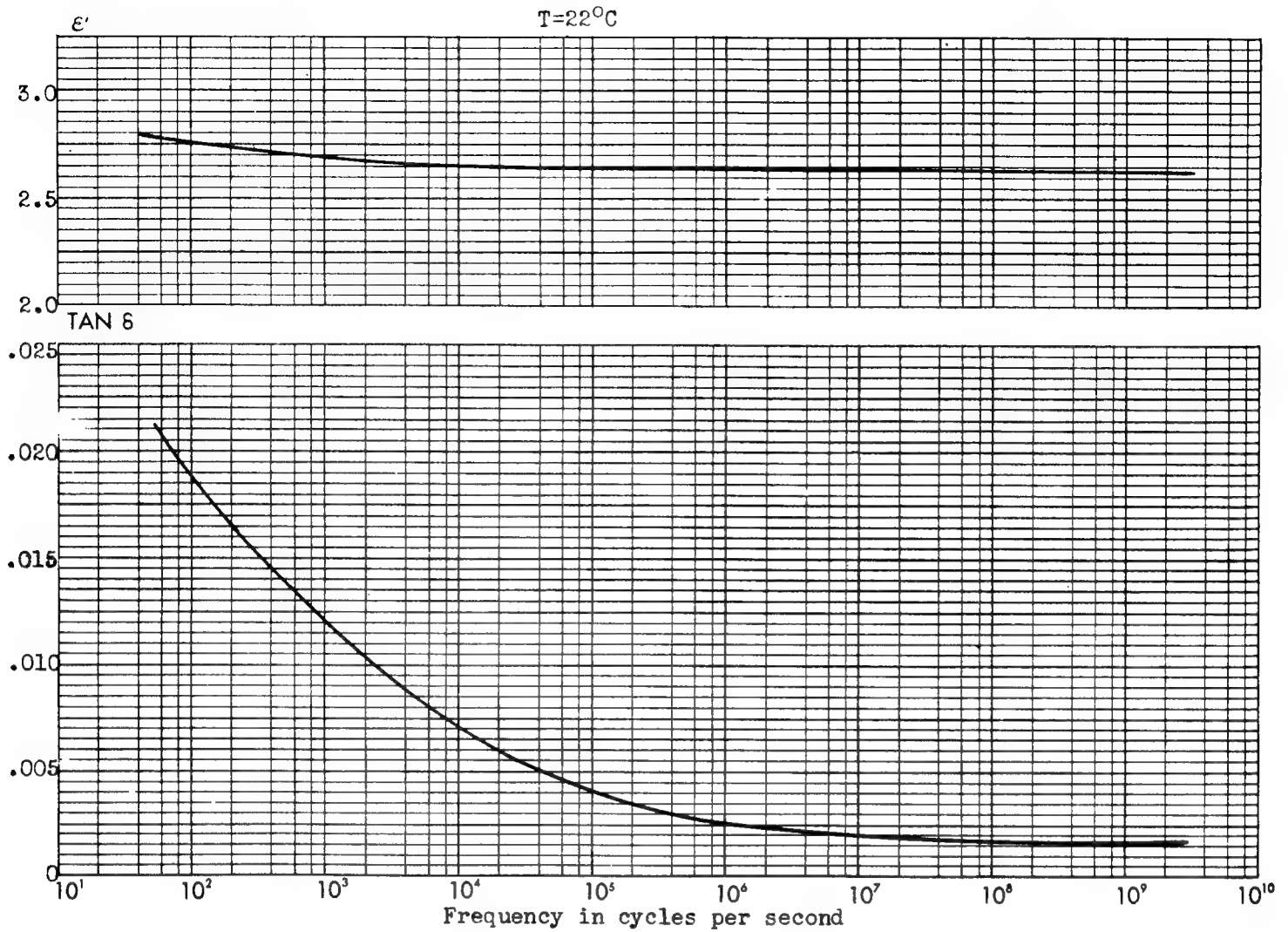
Chemical Name: Cetyl acetamide.

Composition: Synthetic wax.

Properties: Hard brown wax of high lustre.  $d_{25}^{25}=0.975$ ;  $d_{M.P.}^{M.P.}=0.83$ . M. P. 137-139°C. Flash P. 285°C open cup. Chem. Res.: water, excellent; alcohols, good; hydrocarbons, poor. Ac. Val. < 10.

Recommended Uses: Anti-blocking, dental waxes, raising softening point of asphalt without increasing brittleness, electrical insulation, lubricant for thermosetting plastics and bronze powders, "stop off" wax for differential plating, polishes, record waxes, increasing water-resistance of reclaimed rubber stocks, special wax combinations, added to phenol formaldehyde varnishes increasing resistance to salt spray and waterproofing.

Availability: Commercial quantities.

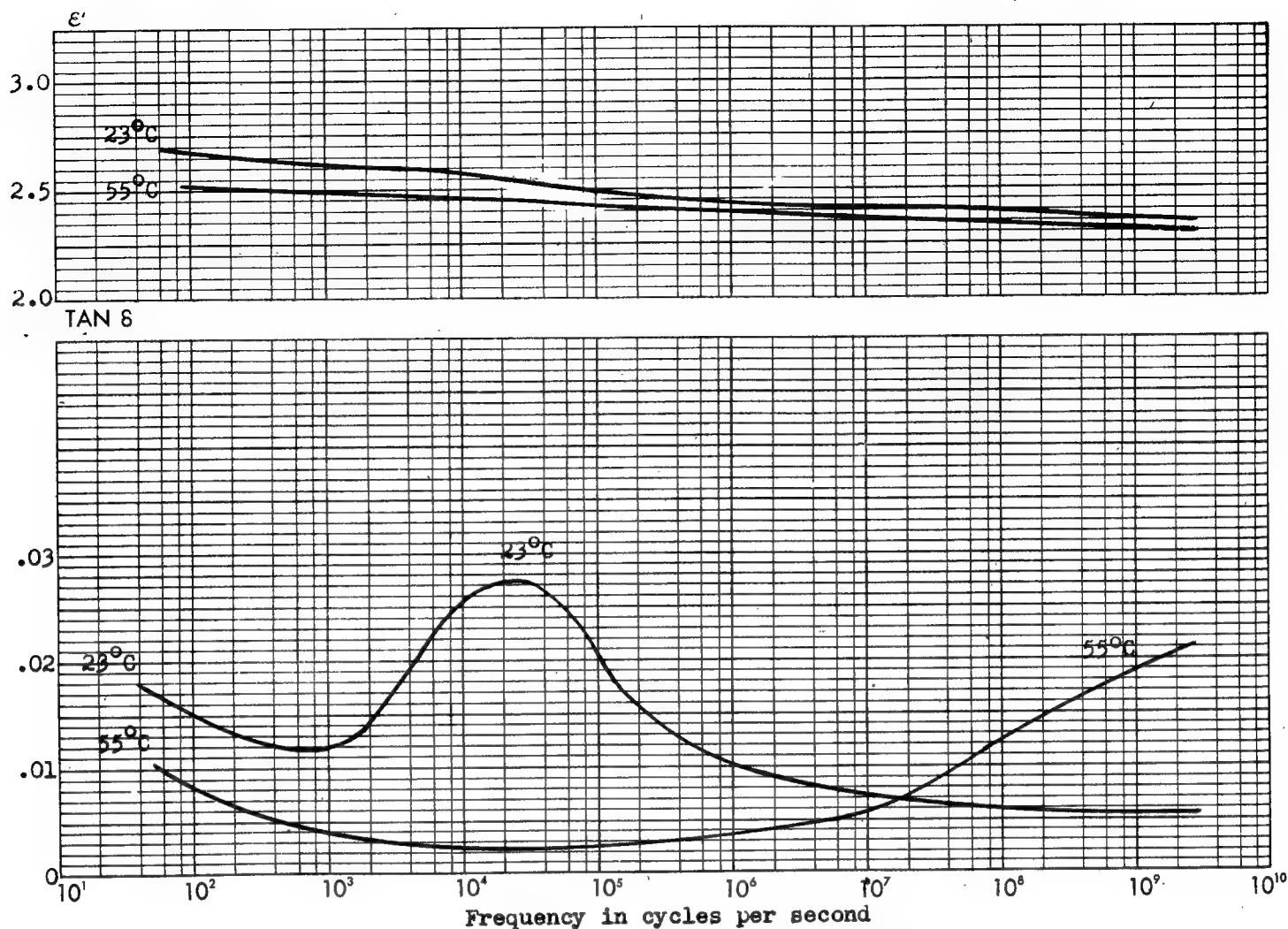


Properties: Black.  $T_{\text{soft}}$  80-90°C. Vapor Pressure  $<10^{-6}$  mm. at 25°C.

Recommended Uses: Sealing wax in vacuum systems.

Availability: Six inch sticks in commercial quantities imported.





Chemical Name: Bleached beeswax U.S.P. Sample Designation: S. F. Brand

Composition: Pure beeswax

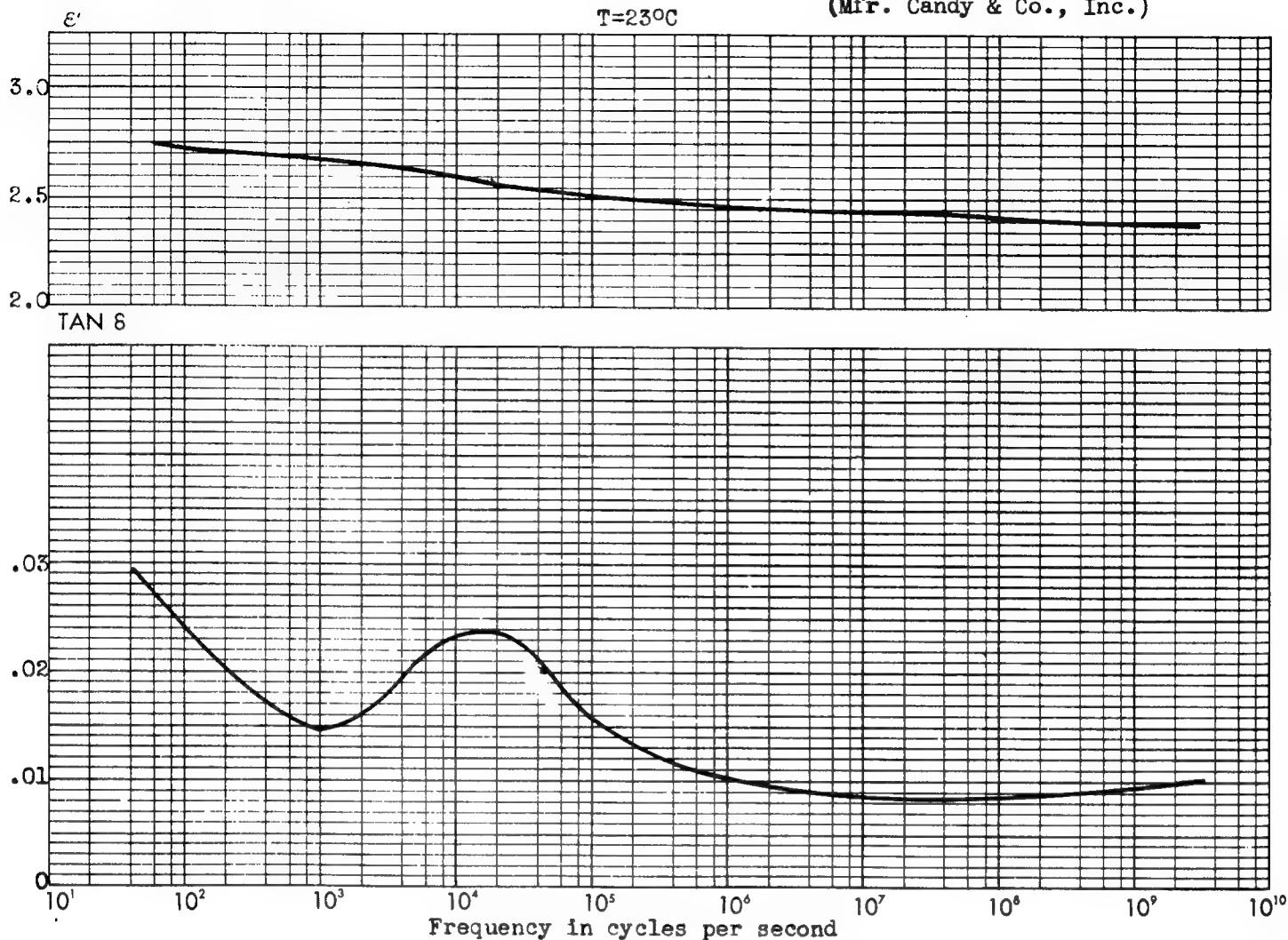
Properties: White.  $d^{25}_4 = 0.950-0.960$ . M. P. 62-65°C (U.S.P. method)

$T_{\text{soft}}$  62-65°C (U.S.P. method). Solvents for: ether, carbon tetrachloride, naphtha and turpentine. Ac. Val. 18-24. Sap. Val. 90-101.

Recommended Uses: Cosmetics, salves, ointments, candles, pomades, adhesive compounds, wax polishes, engraving and lithography, canvas products, leather dressings and polishes, floor also furniture and auto polish, modeling fruits and wax flowers, etc.

Availability: Commercially available.



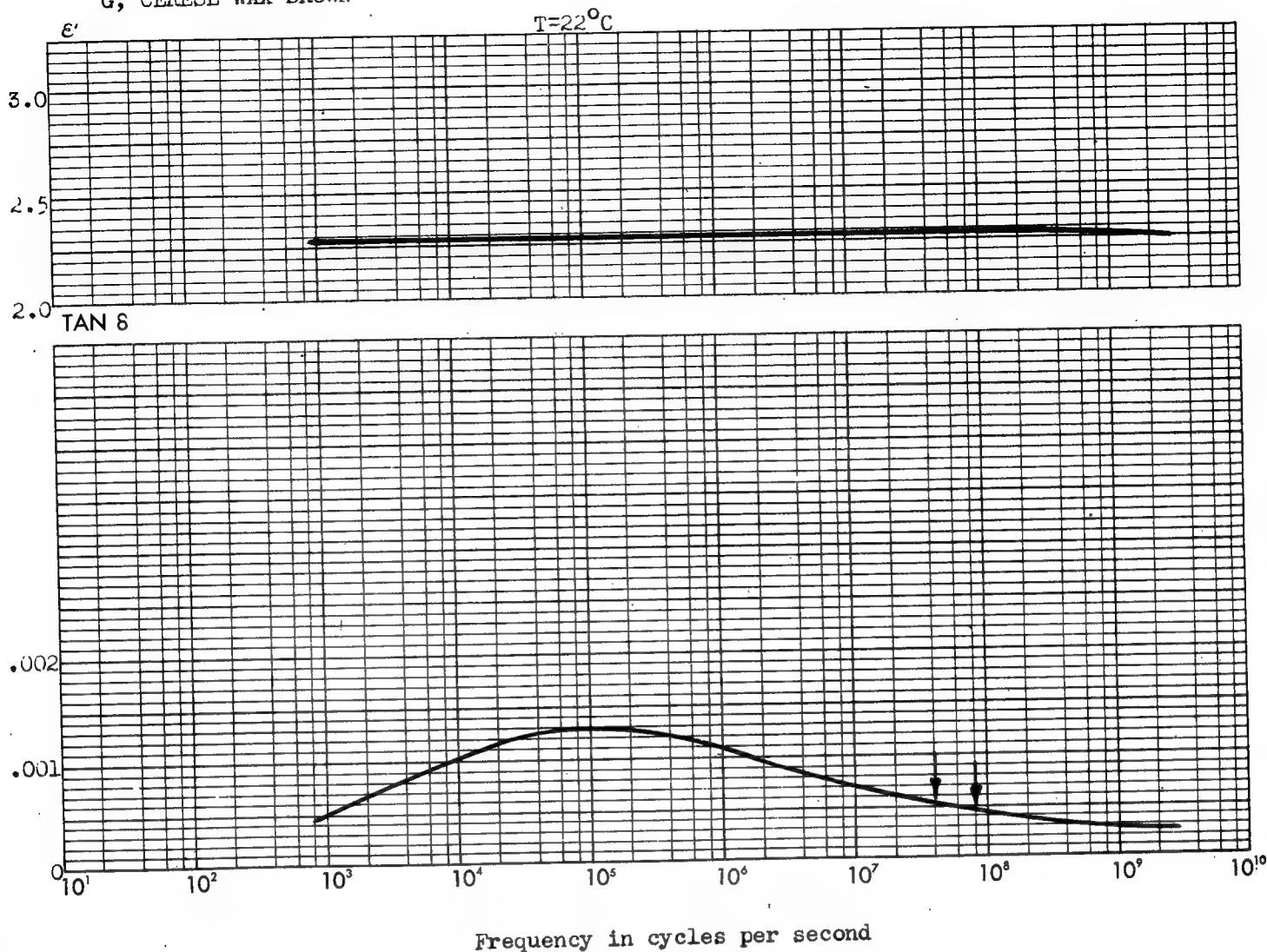


Chemical Name: Yellow beeswax

Composition:- From Lewkowitsch, "Chemical Technology & Analysis of Oils, Fats & Waxes": vol 2, 6th ed.:—Cerotic acid, myricyl palmitate, small amounts of free melissic acid, myricyl alcohol, ceryl alcohol, cholesterol esters, unsaturated fatty acids, hydrocarbons.

Properties: Yellow, opaque.  $d_{25}^{25}=0.946$ . M. P.  $45-64^{\circ}\text{C}$ . Solvents for: chloroform, carbon tetrachloride, benzene, etc.; warm ether and alcohol.

Recommended Uses: Leather dressings & polishes, transparent paper, cements, sizing & finishing for textiles, water-proofing of insulation, etc.



Chemical Name: Petroleum wax.

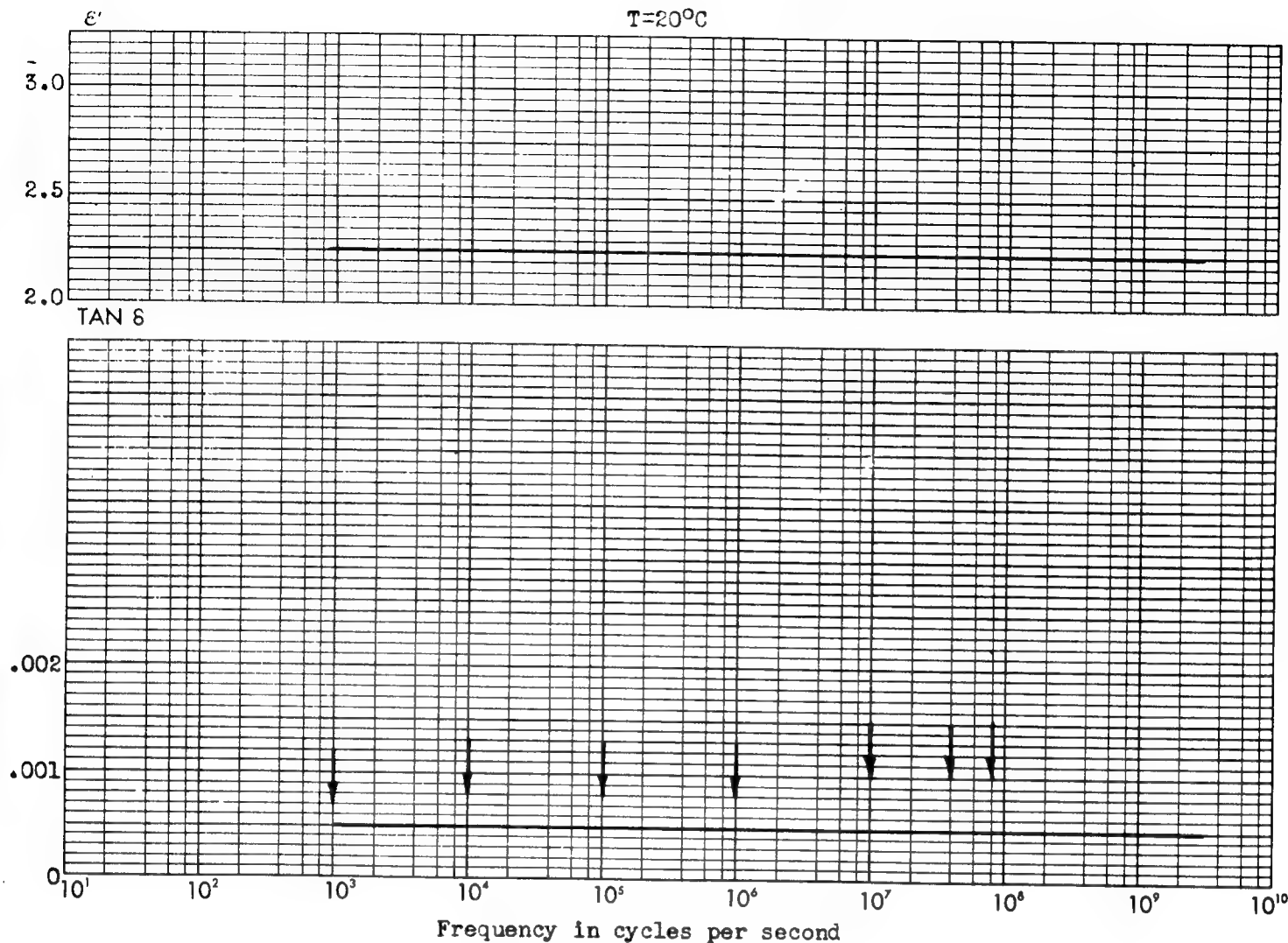
Composition: Petroleum hydrocarbons

Properties: Brown translucent solid.  $d_{15} = 0.922$ . Visc.(sec.) 64. Ten. Str. 244 (Perkins Tester). M. P.  $76.7^\circ\text{C}$  min. Flash P.  $237.8^\circ\text{C}$  min. Therm. Exp.:  $15.5\text{--}37.8^\circ\text{C}$ ,  $2.2 \times 10^{-4}$ ;  $71.1\text{--}76.6^\circ\text{C}$ ,  $5.9 \times 10^{-5}$ . Chem. Res.: acids, good; alkalies, excellent; water, excellent; oxygen, good at ordinary temperatures. Solvents for: benzene, toluene, petroleum solvents, etc. Ac. Val. 0.01. Sap. Val. 0.01.

Methods of Handling: Pouring, flash dipping, impregnating and surface coating from solution possible.

Recommended Uses: Excellent insulating and moisture proofing coating material for a wide variety of industrial applications.

Availability: Commercial quantities under allocation.

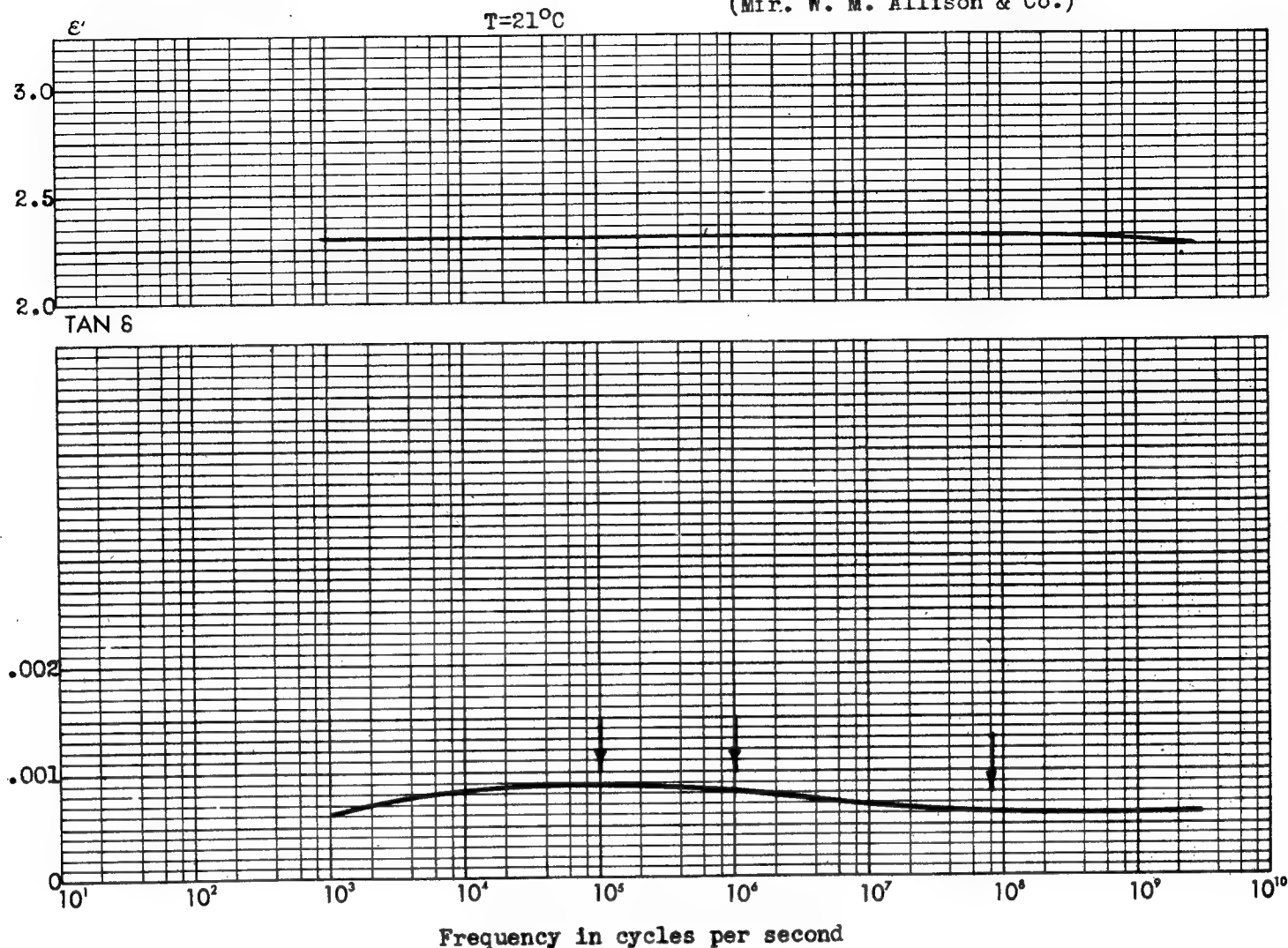


Composition: A combination of vegetable and mineral waxes.

Properties: Yellow and opaque.  $d_{16}^{16}=0.8813$ . M. P.  $138^{\circ}\text{C}$  (Ubbelohde Drop Point).  $T_{\text{soft}} 57^{\circ}\text{C}$  (Ring and Ball). Flash P.  $202^{\circ}\text{C}$  (Cleveland open cup). Ac. Val. 0.12. Sap. Val. 1.66.

Recommended Uses: As an ingredient of insulating compositions; manufacture of cable wax. Other uses are the following: manufacture of candles; lubricants; ingredient of paints; paper industry; perfumery; pharmaceuticals; printing; rubber mixtures; textile industry, etc.

Availability: Available in any quantity at present.



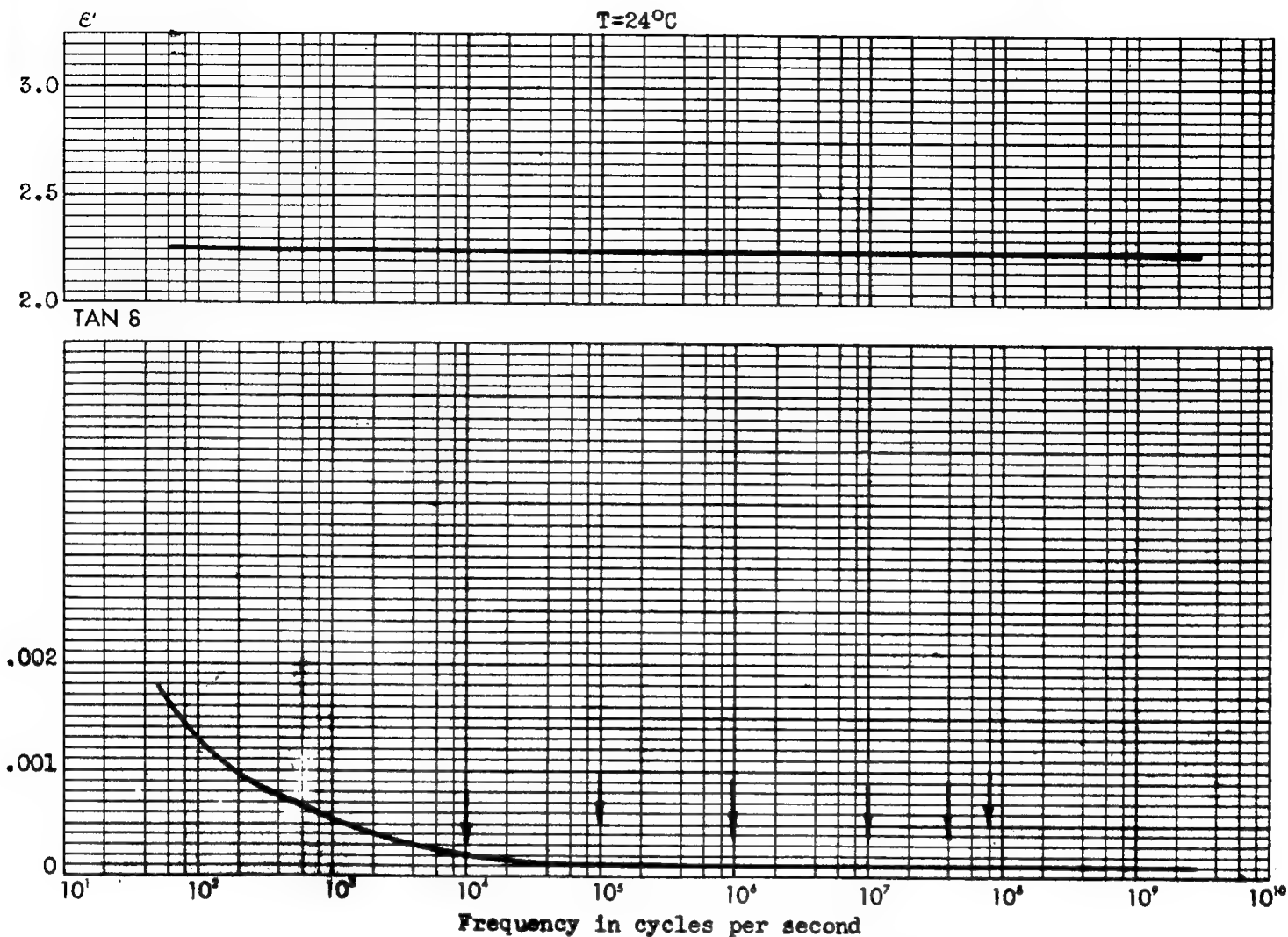
Composition: Native paraffine

Properties: Opaque, brownish-black.  $d_{25}^{25}=0.90$ . Easily cut. M. P.  $53^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: mineral acids, excellent; alkalis, excellent; organic solvents, poor; water, excellent; oxygen, good. Flam.: high.

Method of Handling: Impregnation.

Recommended Uses: Waterproofing of electrical insulation, paper, etc. Temporary sealing.

Availability: Commercially available.



**Properties:** Color, Lovibond 6" cell 510 yellow series 0.2.  $n_{D}^{20} = 1.456$ ,  $n_D^{60} = 0.8100$ .

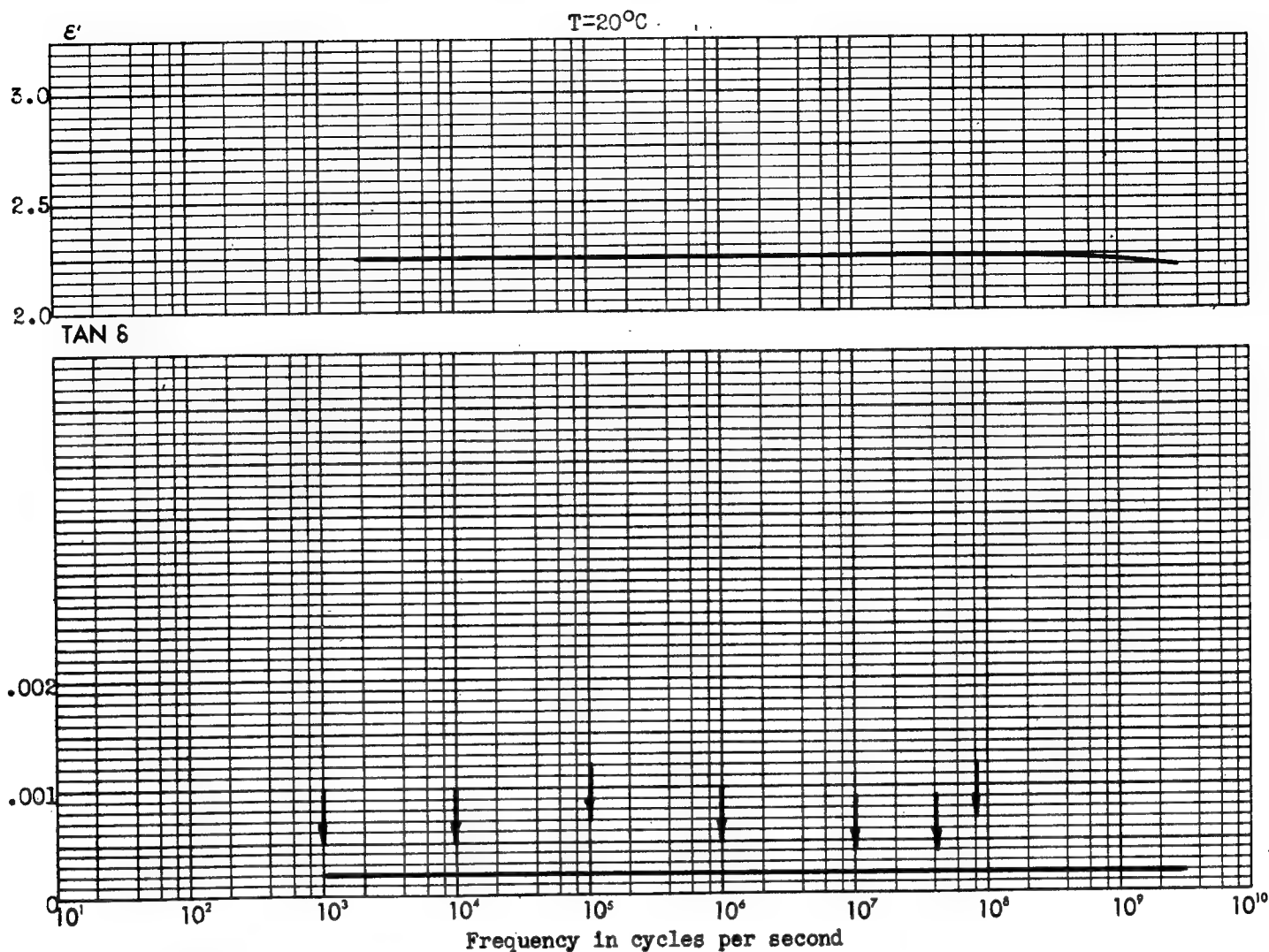
Visc.(sec.): 48 at 60°C, 38 at 99°C. Ten. Str. 85 units (Perkins tester).

M. P. 56°C. Flash P. 213°C, open cup. Chem. Res.: acids, good; alkalies, good; water, excellent; alcohols, good; heated hydrocarbons, poor; heated mineral and vegetable oils, poor. Moist. Abs.: nil. Ac. Val.: nil. Sap. Val.: nil.

**Methods of Handling:** Pouring, flash dipping, impregnating and compression molding.

**Recommended Uses:** Temporary sealing and paper impregnation, etc.

**Availability:** Commercially available.



Chemical Name: Petroleum wax

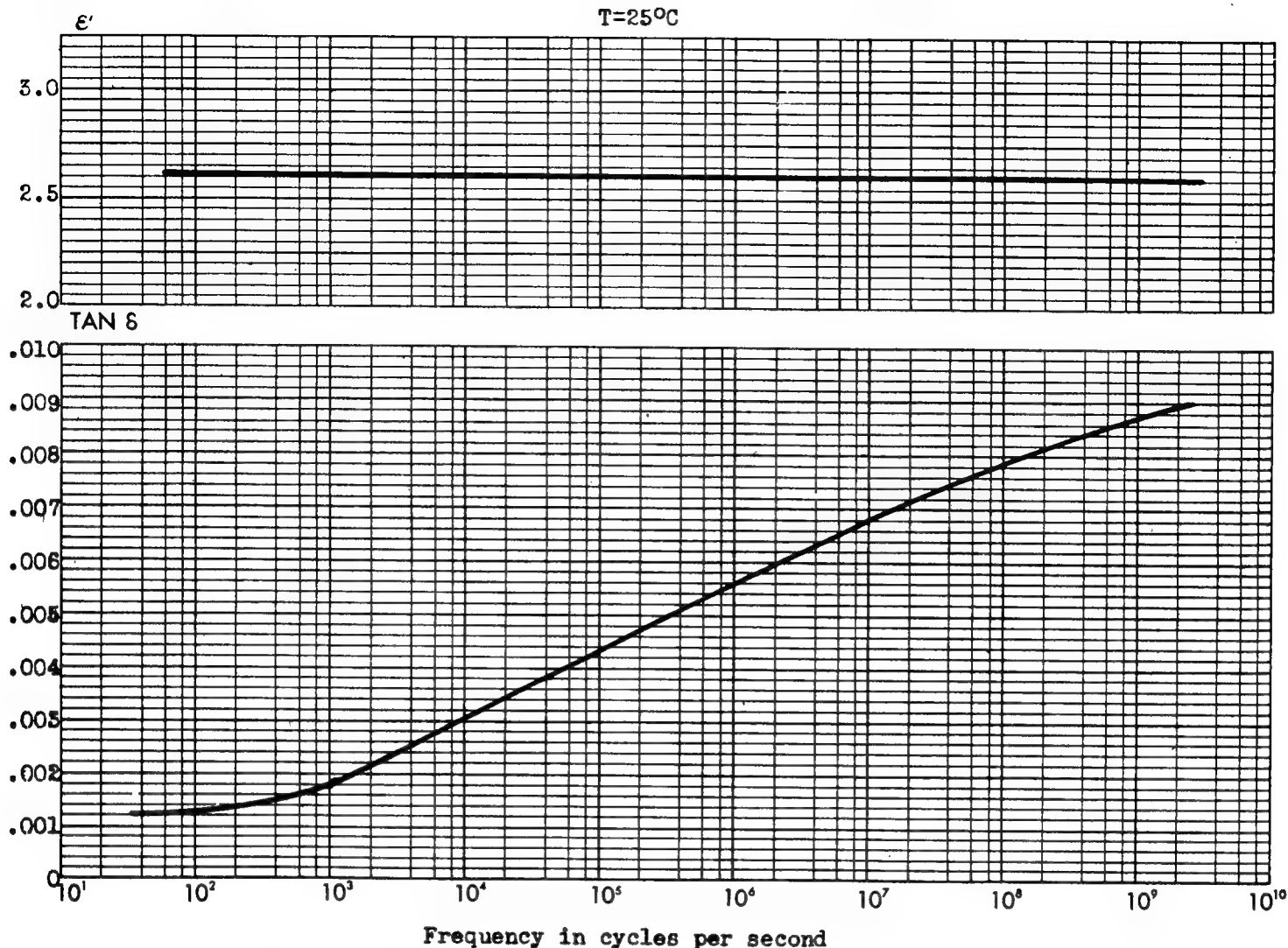
Composition: Petroleum hydrocarbons

Properties: White translucent solid.  $d^{15}_4=0.892$ . Visc.(cs.)  $98.9^{\circ}\text{C}$ , 3.3; Visc.(sec.) 37. Ten. Str. 200 (Perkins Tester). M. P.  $50^{\circ}\text{C}$  (min.). Flash P.  $200^{\circ}\text{C}$ . Chem. Res.: acids, good; alkalies, excellent; water, excellent; oxygen, good at ordinary temperatures. Solvents for: benzene, toluene, petroleum solvents, etc. Ac. Val.: nil. Sap. Val.: nil.

Methods of Handling: Pouring, flash dipping, impregnating, compression molding and surface coating from solution possible.

Recommended Uses: Excellent materials for a wide variety of industrial applications as, for example, coating of bread wrapping paper and sealer for preserve jars.

Availability: Generally available.



Composition: Fossil resin

Properties for tested sample: Clear, yellowish brown.  $d_{25}=1.06$ .  $T_{\text{soft}} 200^{\circ}\text{C}$ .

General Properties: Translucent to clear, light yellow to red brown.  $d_{25}=1.0-1.1$ . Ten. Str. 7500-25,000. Mohs' scale 2-3. Brinell 26-27. Therm. Cond.  $1.8 \times 10^{-5}$ . Therm. Sta.: no decomposition below  $300^{\circ}\text{C}$ . Thermosetting. Chem. Res.: non-oxidizing acids, good; oxidizing acids, poor; alkalies, good; alcohols, esters and ketones, poor; water, excellent. Elec. Str. 2300 av. Surf. Res.: very high.

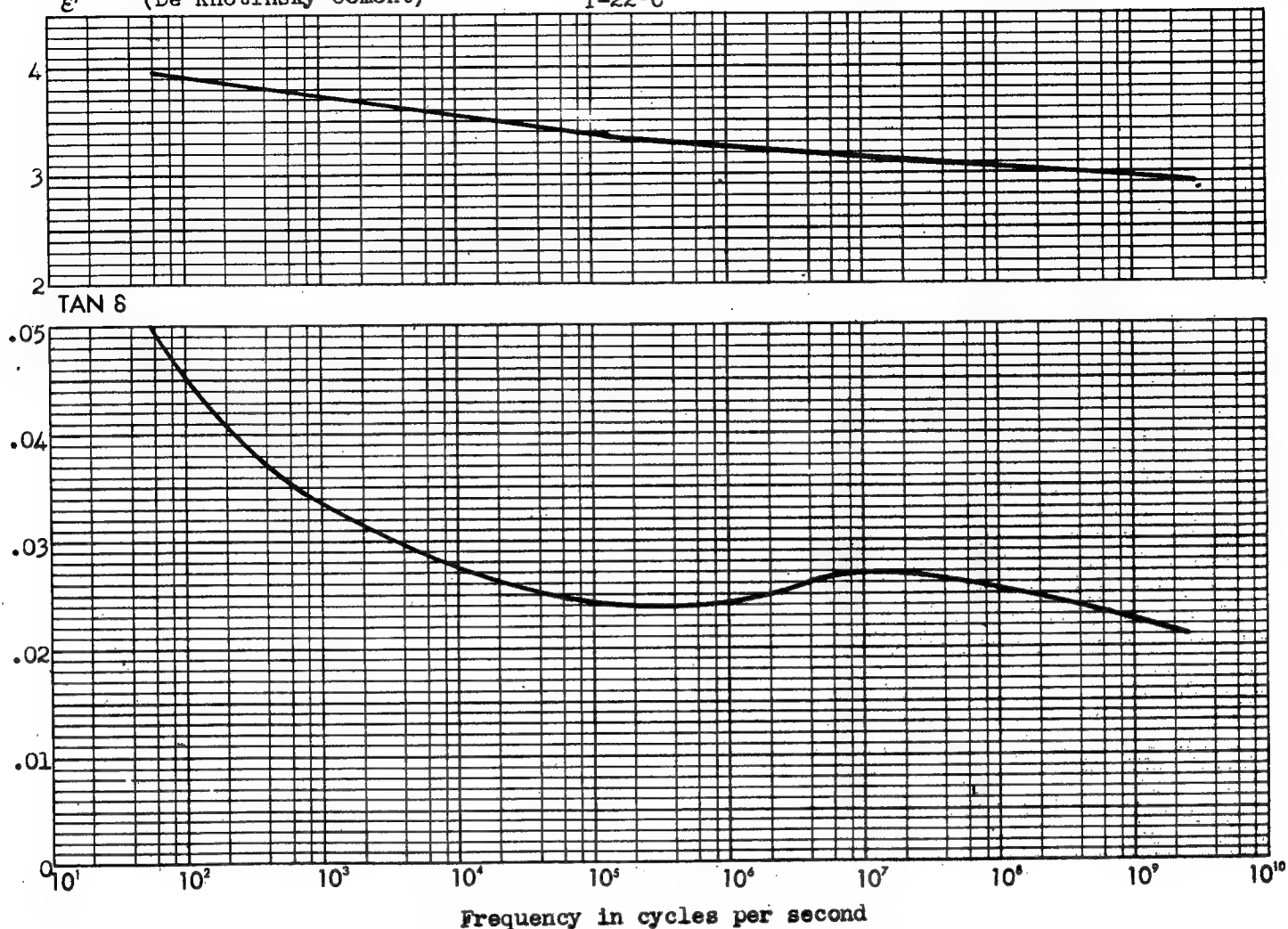
Methods of Handling: Machining from rods or plates.

Recommended Use: Electrical insulation.



$\epsilon'$  (De Khotinsky Cement)

T=22°C

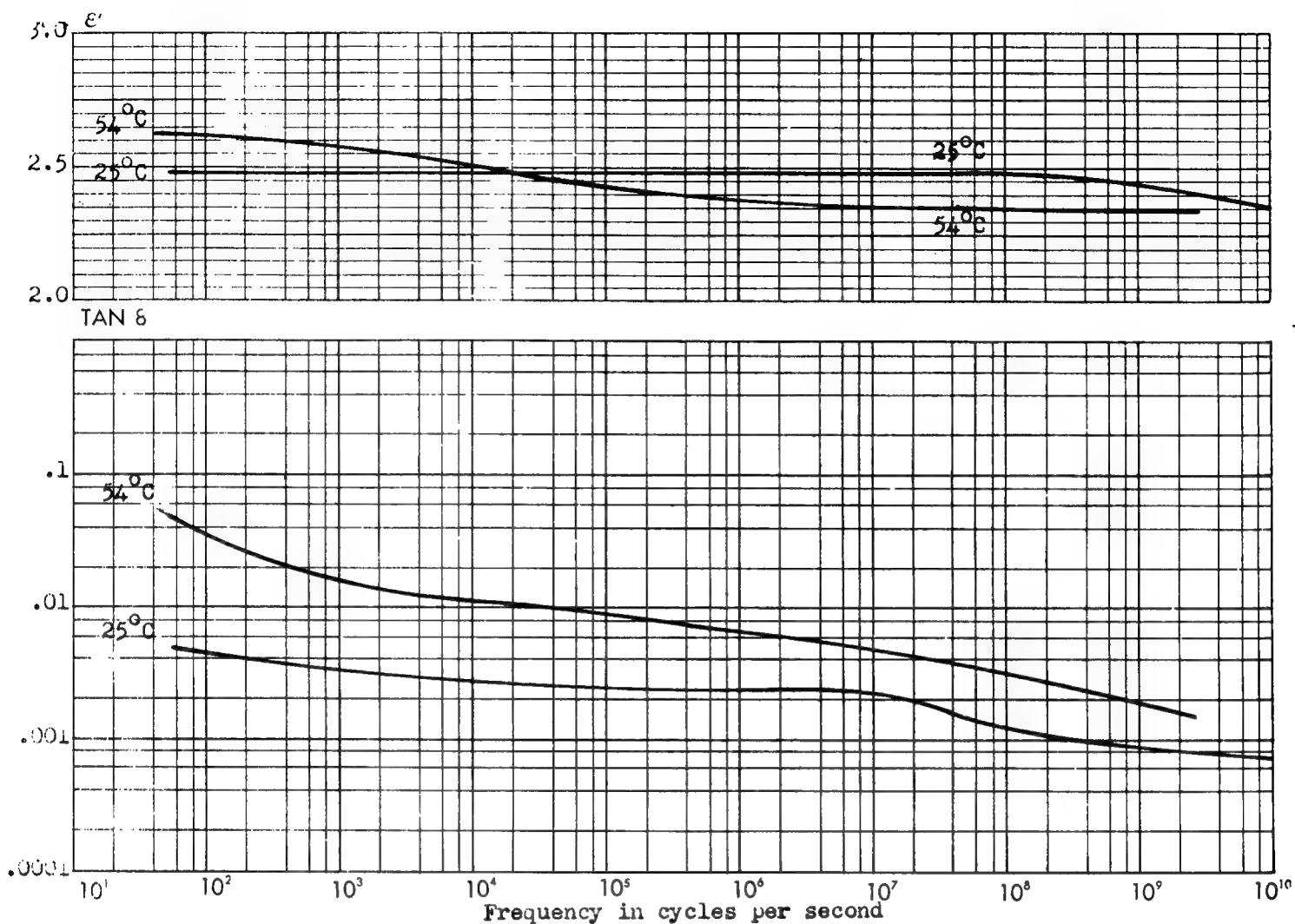


Properties: Light brown.  $d^{25}=1.19$ . Therm. Exp.  $-18$  to  $24^\circ\text{C}$ ,  $9.8 \times 10^{-5}$ . Hard at room temperature.  $T_{\text{soft}}$   $80-85^\circ\text{C}$ . Therm. Sta.: polymerizes slowly at room temperature. Chem. Res.: acids, excellent; alkalies, poor; alcohols, esters and ketones, poor; water, excellent. Flam.: low.

Recommended Use: Adhesive, rigid cement for apparatus and instrument work.

Availability: Commercial product.



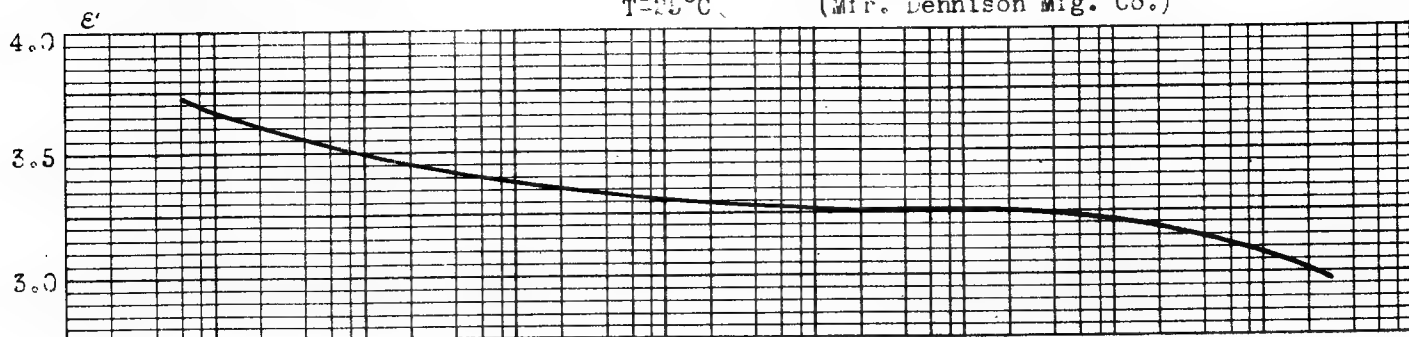
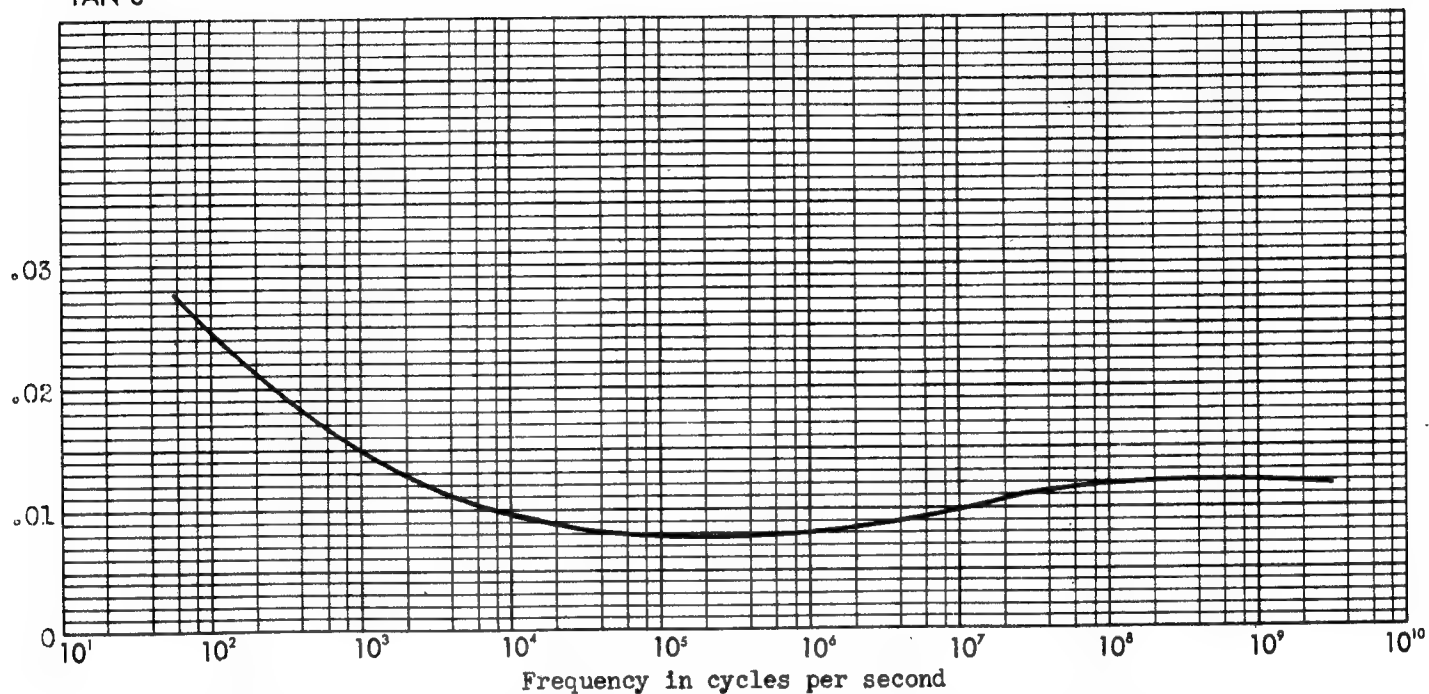


Properties: Opaque, black.  $d_{25}^{25}=1.02$ . Firm at room temperature.  $T_{\text{soft}}$  60-65°C. M. P.: ca. 80°C.  $T_{\text{br}}$  15°C. Chem. Res.: acids, excellent; alkalis, excellent; alcohols, good; aromatic solvents, poor; water, excellent. Flam.: high

Recommended Uses: Seal for leaks in vacuum systems; electrical insulation.

Availability: Commercial product.

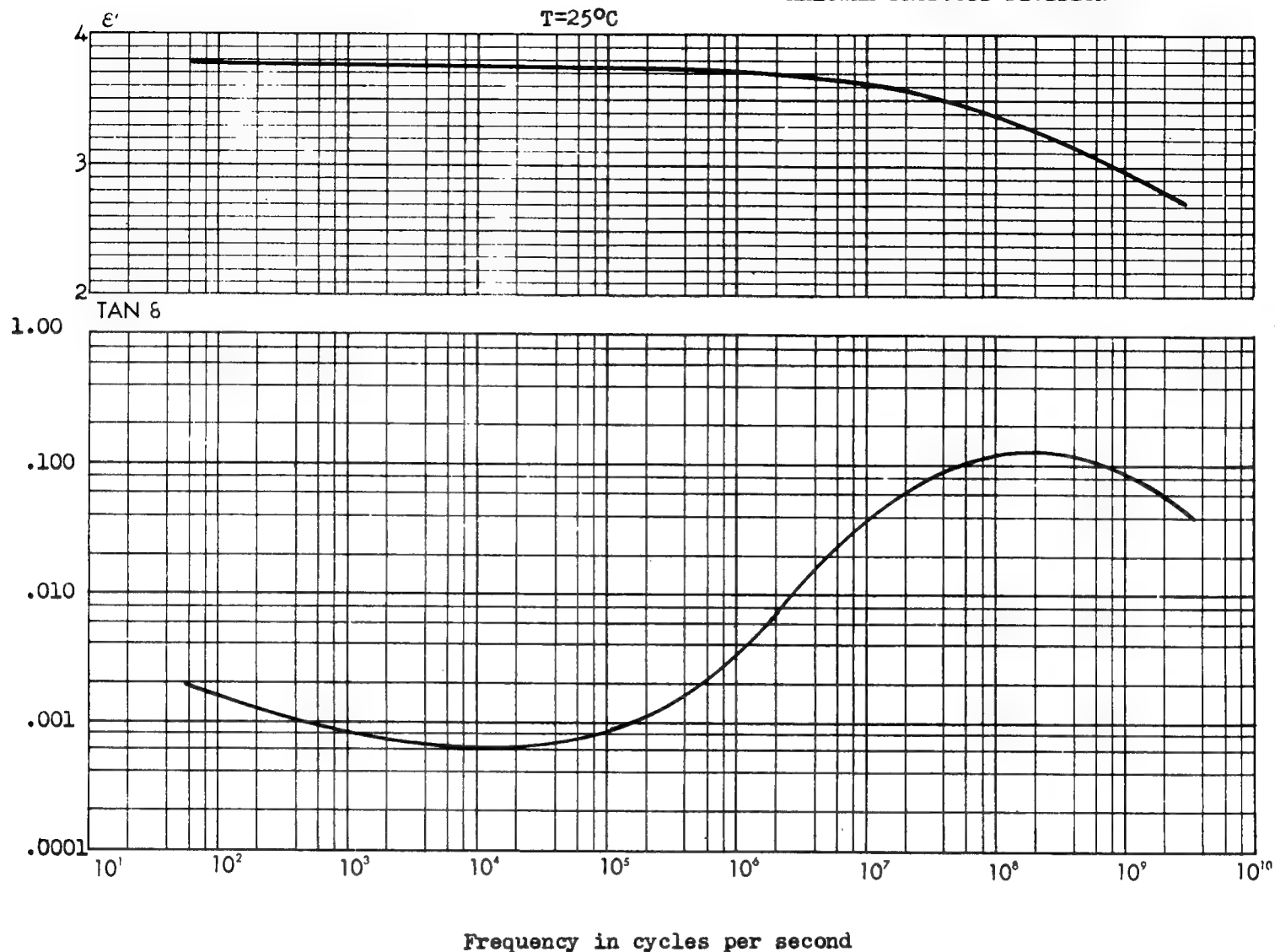
T=25°C

TAN  $\delta$ 

Properties:  $d^{25}=1.27$ . Very hard and slightly brittle at room temperatures.  
M. P.: ca. 75°C.

Recommended Uses: Sealing of joints in glass systems such as those used for low temperature vacuum distillations.

Availability: Commercial product.

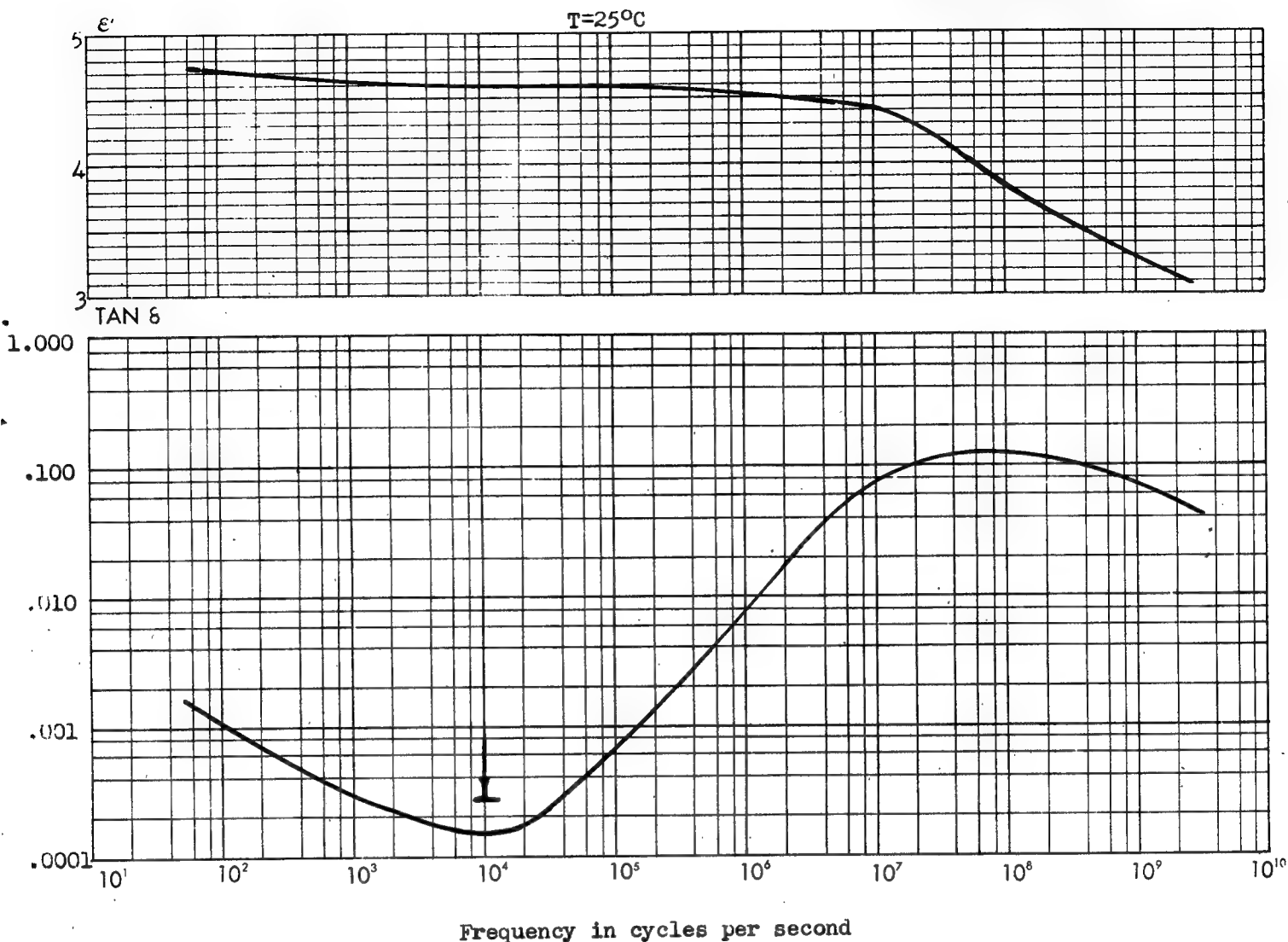


Chemical Name: Chlorinated naphthalene.

Properties: White to pale yellow.  $d_{25}^{25}=1.54-1.58$ . Hardness (Penetration) 10-15. Spec. Heat at  $15.6^{\circ}\text{C}$ , 0.22; at  $100^{\circ}\text{C}$ , 0.65.  $T_{\text{soft}}$   $91-94^{\circ}\text{C}$ . Thermoplastic. Chem. Res.: acids, good; alkalis, good; common hydrocarbon solvents, poor; water, good; oxygen, good. Sun.: darkens on long exposure. Moist. Abs.: low. Flam.: does not burn.

Recommended Uses: Dielectric in paper capacitors.

Availability: Commercial quantities.



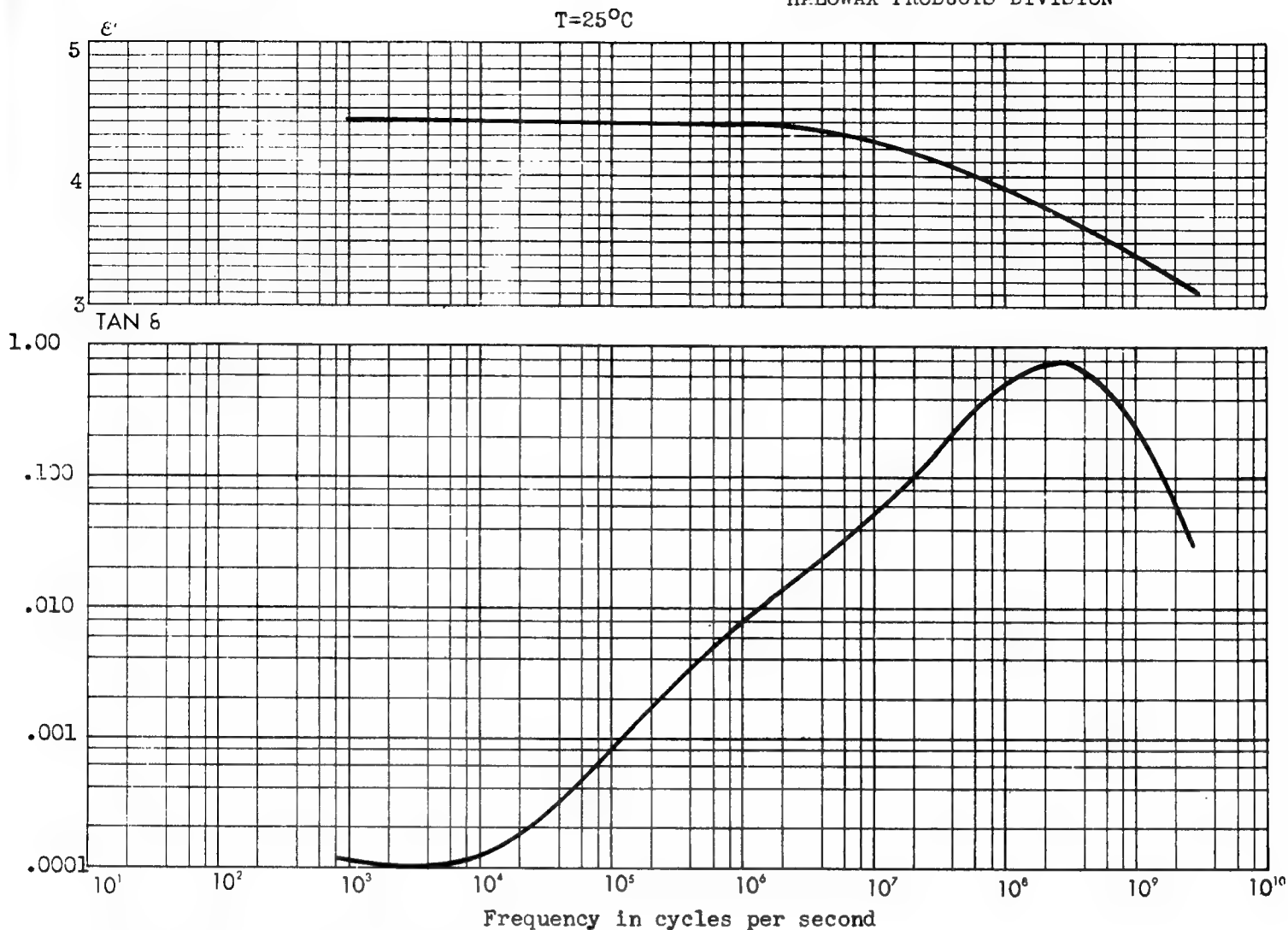
Chemical Name: Chlorinated naphthalene.

Properties: Light straw.  $d^{25}_4=1.65-1.69$ . Hardness(Penetration) 5-8.

$T_{\text{soft}}$  119-122°C. Thermoplastic. Chem. Res.: acids, good; alkalis, good; common hydrocarbon solvents, poor; water, good; oxygen, good. Sun.: darkens on long exposure. Moist. Abs.: low. Flam.: does not burn.

Recommended Uses: Applications where resistance to burning, good chemical resistance, and/or high softening point are required.

Availability: Commercial quantities.

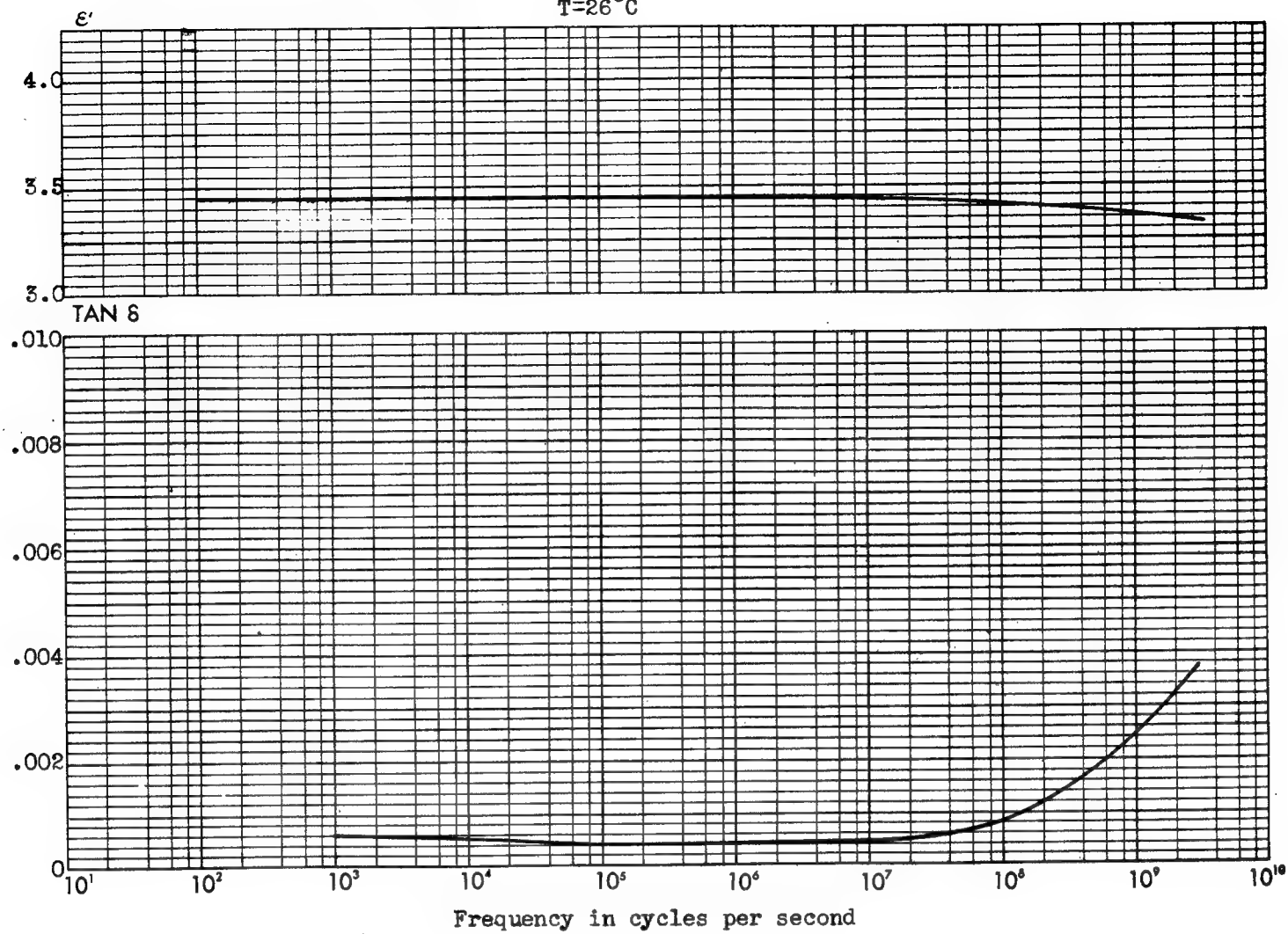


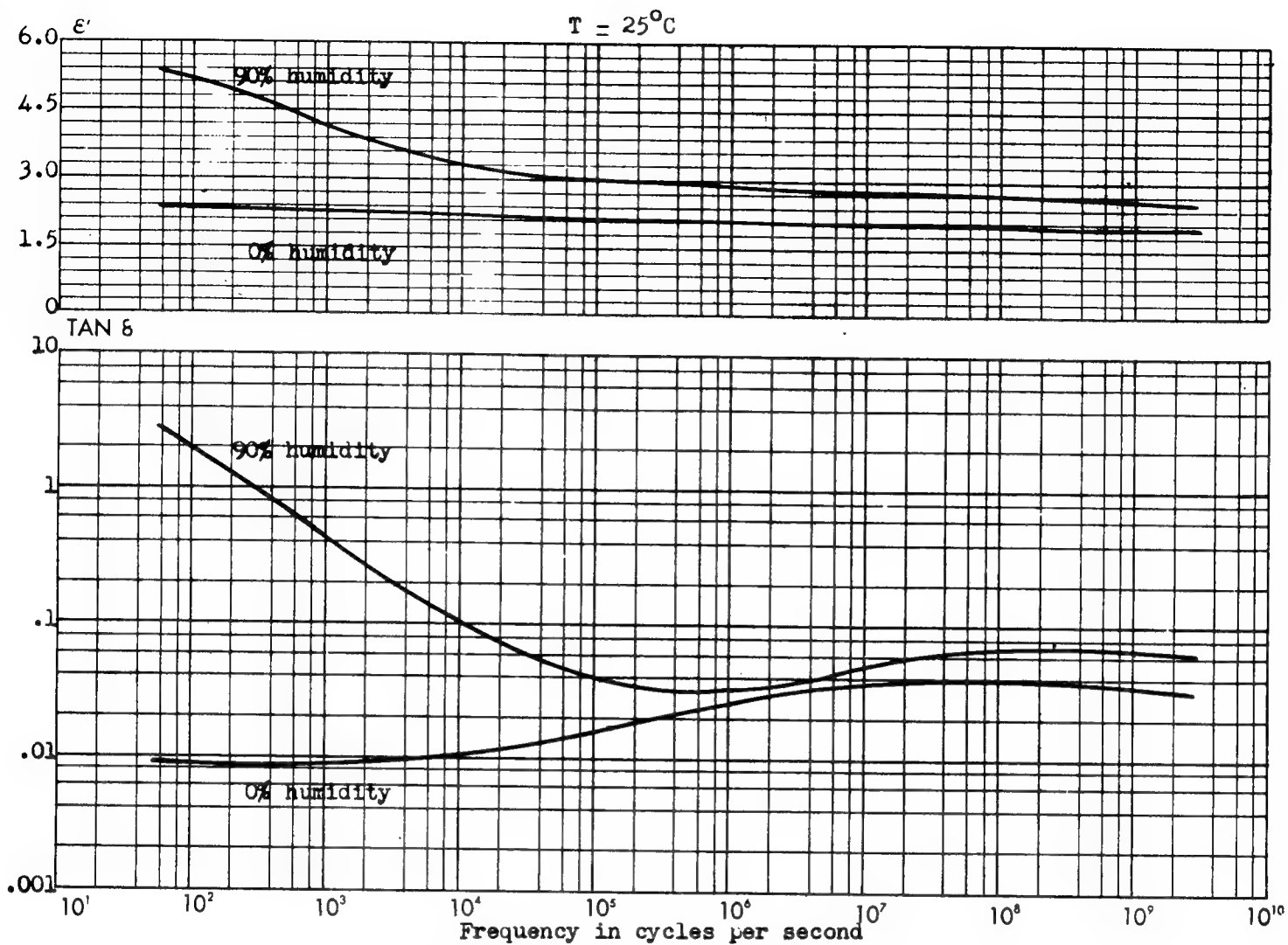
Chemical Name: Chlorinated naphthalene.

Properties: Pale yellow.  $d^{25}=1.76-1.80$ . Hardness (Penetration) 5-8.  
Spec. Heat: at  $15.6^{\circ}\text{C}$ , 0.19; at  $149^{\circ}\text{C}$ , 0.48.  $T_{\text{soft}}$   $136-139^{\circ}\text{C}$ . Thermoplastic.  
Chem. Res.: acids, good; alkalis, good; common hydrocarbon solvents, poor;  
water, good; oxygen, good. Sun.: darkens on long exposure. Moist. Abs.: low.  
Flam.: does not burn.

Recommended Uses: Applications where resistance to burning, good chemical resistance and high softening point are required.

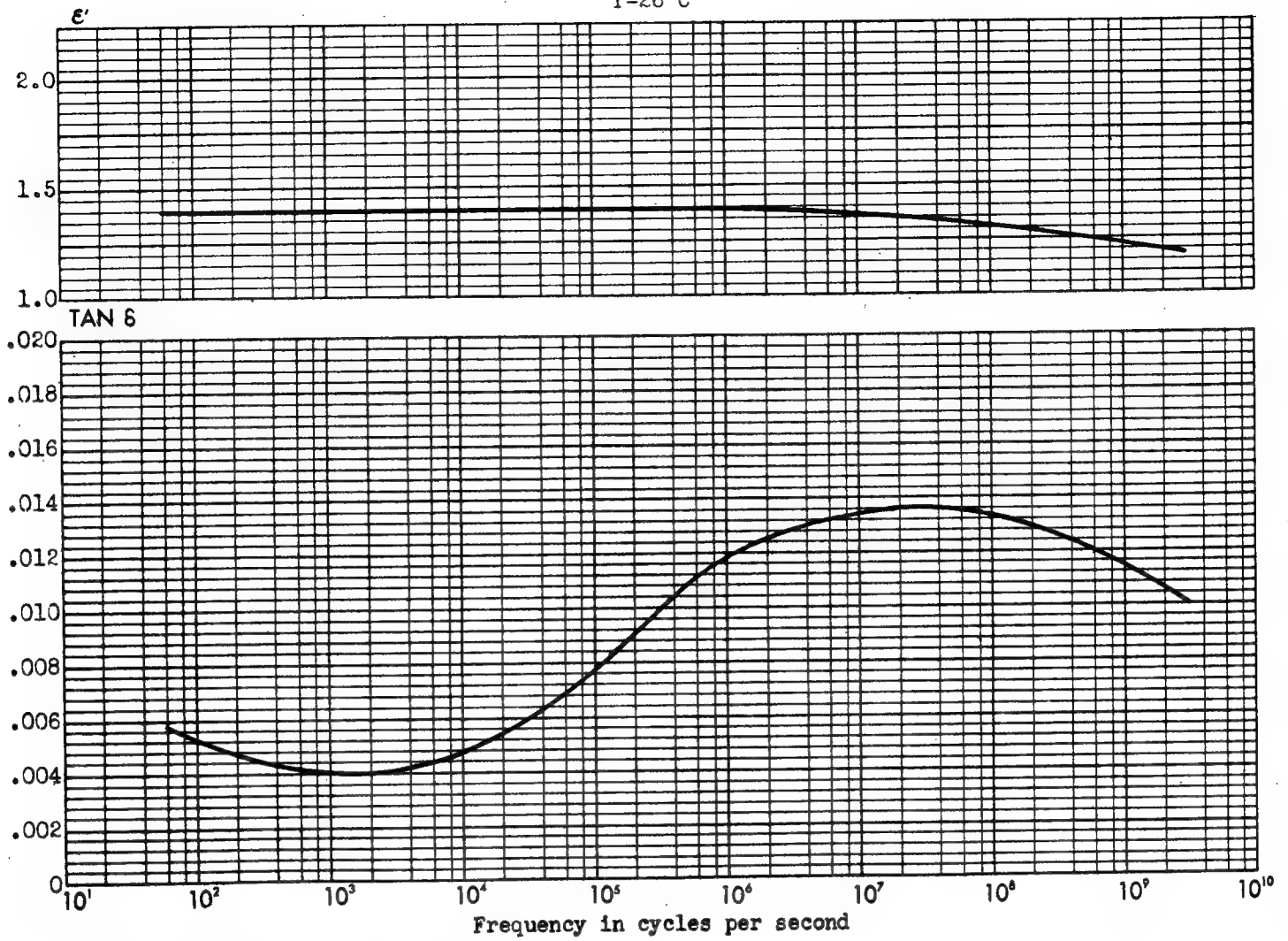
Availability: Commercial quantities.

$T=26^{\circ}\text{C}$ 



Properties:  $d^{25} = 0.668$  air dried. Mod. El.  $1.55 \times 10^6$ .

T=26°C



Property:  $d^{25}=0.12-0.20$  air dried.



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